DOCTOR OF PHILOSOPHY

Devising a Legal Framework for Environmental Liability and Regulation for Mitigating Risks of Shale Gas Extraction

Irowarisima, Macdonald

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Signed Declaration for Submission of Postgraduate Thesis

I, the candidate, hereby acknowledge:

(a) I am the author of this thesis;
(b) Unless otherwise stated, all references cited have been consulted;
(c) The work of which this thesis is a record has been done by the Candidate;
(d) The work has not been previously accepted for a higher degree.

Signed: Date:

Thesis Abstract

The safe extraction of shale gas resources has become a controversial issue in the energy sector and within energy law and policy circle. These issues have transcended to other areas of the society such as the environment, public health, and geopolitics. In fact, in environmental issue and regulation, it has become a norm in the minds of many that finding a model individual to do the right thing is a onerous task. One solution to this problem currently would be to realise the benefits energy resource extraction presents by devising the right regulatory strategies to improve the compliance level of those operating such risky activity to do the right thing. However, the strategic solutions to achieve the benefits are not that complex when compared with the strategic measures for achieving compliance to set regulatory standards for mitigating risks from energy extraction activity. This thesis argue for a complementary regulatory instrument mix (self-regulation and command & control regulatory strategies) to improve effective compliance for mitigating risks associated with energy extractive and consumption activities.

One fundamental problem for this disparity is that the available regulatory strategies and approaches are fraught with diverse limitations that makes it unable to accommodate the dynamic of energy resource extraction. Also, industry and regulators of such activity's dependence on regulatory approaches has been centred on command and control regulation that inhibits the incentive for the operator to go beyond the set standards. Hence, the urgency to devise an effective framework to balance costs that comes with the quest to relaise the benefits from resource extraction activities and the need for the preservation of the environment and health. Though achieving full compliance is far-fetched but optimal compliance is achievable within the context of collective participation amongst all industry players.

One pragmatic means of achieving these conflicting interests within the global energy sector is through alternatives or a combination of regulatory instrument mixes (self-regulation and command and control regulation). This thesis intends that these alternatives should serve as complements to the command and control regulation and not to replace them. Such alternatives to regulation which this thesis argue and formulate that can help mitigate especially water contamination risk which has an increased frequency of occurrence is what it calls: *'the risk/segment based strict liability rule.*' In addition, *'self-regulation'* as a complement to command and control environmental regulation. While self-regulation helps to address the problem of information asymmetry that regulation grapple with, the risk based strict liability rule helps to address risks that have a highly probable or increased frequency level of occurrence. By risk based strict liability rule being proposed in this thesis, it means a risk from an activity can be subject to a strict liability cause of action without necessarily subjecting the entire activity to stricter environmental laws. This is based on the legal rationale that where particular risks' has an increased frequency level of occurrence or the impacts could lead to transgenerational harm, it should be classified as abnormal. Therefore, should be subject to strict liability cause of action. Thus, the philosophy behind this thesis is to see how regulation can deal with particular risks under strict liability when they have an increased frequency to occur and not necessarily the entire activity.

Thus, the significance of this thesis is that it resonates the ability of self-regulation and liability systems to direct the costs of the harms to those who create them. More so, these innovative policy options embedded in the properties of self-regulation and liability system will force operators to incur additional costs needed to forestall or control their actions that might result in externalities beyond the socially optimal level. Thus, environmental governance through self-regulatory and risk/segment liability rule systems as alternatives to command and control regulation will erode that complacency on the part of the creators of such possible negative

impacts to act sustainably. These alternatives to command and control regulation are cogent in mitigating risks associated with shale gas as an energy source on two grounds.

Based on the above problems, this thesis shall examine the critical question of whether stricter environmental liability and regulatory approaches is required to achieve a sustainable shale gas extraction. Also, what other features should be included in these environmental protectionist tools to achieve effectiveness in managing water contamination and dispersed risks associated with fracking activity. This thesis, argue for a stricter liability and regulatory approach as a complement to the limitations of command and control regulation with some added features to address dispersed harms associated with energy extraction activity especially the risk of water contamination.

Abbreviations

BID	The Inter-American Development Bank
CO_2	Carbon Dioxide
CBM	Coal Bed Methane
C&C	Command and Control Regulation
CEPAL	Economic Commission for Latin America and Caribbean
CERCLA	Comprehensive Environmental Response Compensation and Liability Act (USA)
DEP	Department of Environmental Protection (USA)
DOE	Department of Energy (UK)
EAP	European Action Programme (EU)
EIPs	Expected Initial Plans
EPA	Environmental Protection Agency (USA)
FSC	Forest Stewardship Council (USA)
GHGs	Greenhouse Gases
GWPC	Ground Water Protection Council (USA)
HSBC	The Hongkong and Shanghai Banking Corporation (Hongkong)
HVHF	High Volume Hydraulic Fracking
IDRC	International Development Research Centre
IEA	International Energy Agency (USA)
IMF	International Monetary Fund
INPO	Institute of Nuclear Power Operators
NEPA	National Environmental Protection Act (USA)
NOFPA	Northwest Organic Food Producers Association
NORMS	Naturally Occurring Radioactive Materials
NRC	Nuclear Regulatory Agency
OECD	Organization for Economic Cooperation and Development
Operators	Shale Gas Extraction
OSHA	Occupational Safety and Health Administration (USA)
PPI	Progressive Policy Institute (USA)
PPP	Polluter Pays Principle
PP	Precautionary Principle
PSAs	Production Sharing Agreements
RCRA	Resource Conservation and Recovery Act (USA)
SDCs	Sustainable Development Commission (UK)
SDGS	Sustainable Development Growth
SDWA	Safe Drinking Water Act
STRONGER	State Review of Oil and Natural Gas Environmental Regulation
UCG	Underground Coal Gasification
UOG	Unconventional Oil and Gas
UOGE	Unconventional Oil and Gas Extraction
UK	United Kingdom
USA	United States of America
USEPA	The United States Environmental Protection Agency
VOC	Volatile Organic Compounds
WVDEP	West Virginia Department of Environmental Protection (USA)
WWFN	Worldwide Fund for Nature

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Chapter 1

1.1 Understanding Shale Gas in Energy Law

The energy industry has witnessed success in the exploration and development of unconventional resources as evidenced by shale gas boom.[1] This, no doubt is a great way forward in the global energy sector in relation to the theoretical and technological innovation. Accordingly, the shale gas boom has to an extent broken the existing lower limit of conventional reservoir and the traditional idea of trap accumulation, and reinvested the geological theory of petroleum and gas with new connotations.[2] This phenomenon has changed the dimension of exploration and development types and the amount of hydrocarbon resources. More so, it has overturned the postulations known as "peak oil" and "oil depletion". Innovative application of massive technologies represented by multistage fracturing of horizontal wells has led to the advances in technology in the energy industry.[3] Through these massive technologies that account for the shale gas revolution, America's external dependence on oil and gas is said to be rapidly declining.[4] The global energy structure is not left out in this significant alteration.

Presently, shale gas exploitation in the United State (U.S) is rapidly expanding.[5] A study by the U.S Energy Information Administration (EPA) which focused on the last decade of U.S shale gas production and made future projections,[6] stated that during the period of 2014, production increased by eight hundred percent, of which shale gas accounted for ten percent of total U.S gas production, and over twenty percent of total remaining recoverable gas in the U.S will be discovered in shale basins.[7] Thus, it will be difficult for any pundit to contest the economic benefits from the U.S experience.

Likewise, countries within Europe, Asia and Africa. A typical example is Poland. Previously, Poland was only seen as a large Coalbed Methane (CBM) producer.[8] However, shale gas production since 2009 has received a lot more attention in Poland than their CBM resources.[9] According to documented estimates by an oil and gas group, Poland's shale gas reserves could potentially be as high as forty-eight trillion cubic feet of natural gas.[10] The estimated report coupled with other reports conducted by the International Energy Agency (IEA), corroborates the enormous undiscovered reserves that have attracted ExxonMobil, Lane Energy, Talisman, Chevron, and Aurelian Oil and Gas.[11] Massive efforts towards exploration and production have already occurred even in the relatively short-time span between initial reports estimating

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[1]Meng, Q. (2014). Modelling and prediction of natural gas fracking pad landscapes in the Marcellus Shale region, USA, Landscape Urban Planning. 121, pp.109-116.

[2]Yongsheng, M, *et al.,* (2018). China's Shale Gas Exploration and Development: Understanding and Practice. Beijing: Geological Publishing House *Petroleum Exploration and Development, Volume 45, Issue 4* at p.589-603

[3]Ibid.

[4]See supra Meng, Q. (2014) footnote 1 p.116.

[5]See supra Yongsheng, M, *et al.,* (2018) footnote 2 at p.381.

[6]U.S. Energy Information Administration, (2010). Annual Energy Outlook. [Online] http://www.eia.doe.gov/oiaf/aeo/pdfl0383(2010).pdf. [Accessed On 23/06/2018]

[7]Ibid at p.8.

[8]See International Energy Agency [IEA]. (2010). *Medium-Term Oil & Gas Markets, [Online]* http://www.iea.org/publications/freepublications/publication/mtogm2010.pdf [Hereinafter IEA] [Accessed 04/05/2018].

[9]Ernest, W. (2011). Path to prosperity or ruin? Shale gas under scrutiny. PISM [hereinafter Polish Institute. of Int'l Affairs] p.18.

[10]Ibid.

[11]Susan, L. S. (2011). 'The global shale gas initiative: Will the united states be the role model for the development of shale gas around the world? 33 *Houston. Journal of. International Law*. 369, 394.

the size of the reserves and the present day.[12] The Polish government has granted over forty five exploration licenses for shale gas and is actively promoting drilling activities within its territory.[13]

Whilst Poland within the European region is eager to explore and extract its shale resources, some countries like France have issued national moratoria toward the further exploration and production of shale gas.[14] This is based on the environmental concerns stemming from groundwater contamination and landscape destruction. Finally, the EU has been less optimistic regarding shale gas development. Also, Bulgarian government released a memorandum on January 17, 2012 signalling its preparation for a "full ban on shale gas drilling against the backdrop of environmental concerns" too.[15] The memorandum that was released by the Bulgarian government led to the cancellation of an exploratory permit given to Chevron for locating and preparing to drill shale gas in the North Eastern Bulgarian reservoir.[16] Britain suspended deep-excavation practices near Blackpool as a result of an earth tremor measuring 2.3 on the Ritchers scale felt in the Lancashire seaside resort as well as an earth tremor measuring 1.5 scale in May, 2011.[17]

Reasons such as environmental and health risks, economic prospects, basic infrastructure and market challenges are responsible for the setbacks in the development of shale gas in the context of energy law perspective in the EU and elsewhere. Among these reasons, environmental risks ranging from water contamination, earthquakes, air pollution, water use and community impacts have been a source of concern for the safe extraction of shale resources. Energy law in recent times have shifted from just addressing: how to generate electricity, mine coal, extract oil and gas, and distribute energy sources. Its focus has transcend to energy efficiency, demand side management, and the sustainable development of/use of energy.[18]

Shale gas is an energy source and its risks and benefits must be regulated within the ambit of energy law and policy framework principles. This is crucial because energy law is the regulation of energy related rights and duties of various stakeholders over energy resources over the energy life-cycle.[19] Nevertheless, for energy law to further develop, and to be effective, it must take into account the advances in society in terms of technology and the inevitability of risks emanating from such technological advancement. This twist is more evident in the energy industry as the energy law regulatory framework strategies have failed to address these growing level of risks emanating from technological advances in the shale gas extractive industry.

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[12]See supra Meng, Q. (2014) footnote 1 at p.109.
[13]Neil, B. (2012*).* Resources: Shale gas will have its day in Europe-but not just yet*, Financial Times* (8: 50 PM), [Online] http://www.ft.com/cms/s/0/3b56d8b2-1c42-11e2-a63b-00144feabdco.html#axzz2nnxvgwfw (noting that while Poland proceeds with shale development, several countries have delayed or banned exploration). [Accessed on 20/05/2018].
[14]Ibid.
[15]Marcin, S. (2011). 'Resistance to Poland's shale gas exploration plans emerging' *Wall Street Journal.* [Online] http:/www.iblogs.wsj.com/emergingeurope/2011/08/05/resistance-to-poland's-shale-gas-exploration-plans-emerging [Accessed 02/04/2018].
[16]Tsvetelia, T. (2012). 'Bulgaria Cancels Chevron Shale Gas Permit' *Reuters* [Online] http://www.reuters.comlart cle/2012/01/17/us-bulgaria-shalegas-chevronidustre80g18j20120117. [Accessed on 18/05/2018]
[17]Ibid.
[18]Heffron, J. R. *et al.,* (2018). A treatise for energy law, *Journal of World Energy and Business, at p.39-46;* AJ Bradbrook and RD Wahnschaft, The Law of Energy for Sustainable Development (CUP 2005).
[19]Heffron, J. R & Talus, K. (2016). "The evolution of energy law and energy jurisprudence: Insights for energy analysts and researchers, *Energy Research & Social Science* 19, pp.1-10.

However, the geological and formation differences associated with shale plays across the world present different nature and degree of increased frequencies of risks. For example, in the US, there is said to be a concern over increased frequency of water contamination.[20] In China, an increased frequency of earthquake risks has caused a clog in the wheel of development of shale gas resources.[21] The United Kingdom (UK) share similar experience as well as the fact that most of its shale reserves are located just directly below water aquifers.

Based on these increased frequency of risks and the transgenerational harm associated with the extraction of shale gas, this thesis argues that such increased frequency of risk associated with an activity provokes a need for stricter environmental liability and regulatory regime for the mitigation of risks. It is the argument of this thesis that where such increased frequency level of risk that leads to transgenerational harm is prevalent in an activity, it connotes a high probability of risk occurring which automatically makes that activity to be abnormally dangerous. Therefore, a strict environmental liability and regulatory regime will encourage operators of such activity to go beyond the C&C regulatory standards. This in turn, promotes the incentives for industry to self-regulate which acts as indirect regulation.

To this end, this thesis formulates a new rule known as the *'risk/segment based strict liability rule'* to mitigate increased frequency of risks associated with an activity on one hand. In addition, the thesis proposed a self-regulatory approach as a complement to command and control otherwise known as a prescriptive form of regulation. C&C creates a problem whereby perpetuators of harms might be shielded from liability on the basis that they have satisfied the set standards and requirements for carrying out such activity. This thesis postulates that using the 'risk/segment based strict liability rule' and the properties of 'self-regulation', activities that present highly probable risks, would be made liable even though they have complied with the set standards.

This thesis provides support for a complementary approach for environmental regulation using the risk/segment based strict liability rule and self-regulation to improve the role of C&C regulatory approach in mitigating increased frequency of risk associated with an activity on the ground that--risk that have a high probability rate of occurring should be categorized as abnormal and subject to a stricter environmental liability cause of action.

An identification of good principles will be explored to determine whether a given activity is best reserved to be controlled by liability or regulation. The very essence of this is to avoid wasting time on the already contentious debates about whether additional regulation is required, but rather will focus on useful discussions on how both systems can be made more resilient in reducing risks associated with energy extraction activities. While enough options in terms of policy initiatives exist for improving shale gas regulation, the options for improving liability systems has not been sufficiently examined. This, needs to be addressed considering the significant role liability play in ensuring and encouraging the exercise of care by operators and thus managing the risks involved.

Thus, the aim of this thesis is to clearly contribute to energy law and policy formulation by stating that in order to reduce the increased frequency levels of risks associated with water contamination in shale gas fracturing and other sources of energy extractive activity, it is

[20]Rozell, D. J & Reaven, S.J. (2012). Water pollution risk associated with natural gas extraction from the Marcellus shale, *Risk Analysis,* Volume 32, Issue 8 [Online] http://www.otsego2000.org/wpcontent/uploads/2012/11/Water_Pollution_Risks_Associated_wtih_Marcellus_Shale-3.pdf (Accessed on 23/02/2017).

[21]China Youth Daily. (2013). China should approach shale with caution. Retrieved from Tencent News Editorial: http://view.news.qq.com/a/20130506/000048.htm (Accessed on 23/02/2018)

imperative that stricter environmental and liability approaches and the promotion of the tenets of self-regulation are included in the energy policy measures to mitigate risks that may arise as technologies advances in society. Thereby, upholding the energy law principle to protect the environment, human health and combatting climate change of which certain risks of shale gas extraction pose a threat as evidenced in water use and contamination and earth tremors and quakes in regions most likely to be prone to them. A typical example, is China where there are increased frequency level of earthquakes and in the UK where groundwater contamination and earth tremors concerns have raised agitations where test sites exists.

Furthermore, this thesis contributes to modern energy law in that it resonates the urgency for reviewing the present risk mitigating measures in the global energy sector that has been overturned by advances in technologies in the industry. New strategies that are self-sustaining are needed if energy law which is about regulation of the rights and duties of stakeholders and promotion of energy justice and prudent, rational and sustainable use of natural resources needs to be proactive in tackling the attendant issues highly probable risks. Thus, this thesis states that as long as human activity is concerned risk is inevitable and as such the strategies to mitigate these risks must be strengthened. Otherwise the seven principles of modern energy law which include the: the principle of natural resource sovereignty; the principle of access to modern energy services; the principle of energy justice, the principle of prudent, rational and sustainable use of natural resources; principle of the protection of the environment, human health and combatting climate change; the principle of energy security and reliability and the principle of resilience.[22] These principles will be defeated in achieving its purpose in the energy law if the subject of risk mitigation is not strengthened further beyond the traditional C&C form of regulation and the implementation of stricter liability regimes.

This is crucial in that at the core of energy law is the regulation of energy carriers and energy activities which pertain to rights and duties of various stakeholders over energy resources. This very foundation of energy law fits perfectly with the objective of this thesis which is to foster effective compliance with set regulatory and liability systems for the purposes of building up on some of the principles of energy law as discussed by Raphael J.Heffron and others in their article titled *"A treatise for energy law*".[23] Particularly, the principle of prudent, rational and sustainable development of natural resources and the protection of environment. Thus, by improving compliance through the deployment of self-regulatory and stricter liability measures in mitigating risks from energy activities, goes to further strengthen specifically the principles mentioned above through sound regulatory policy objectives.

Thus, the use of stricter liability and self-regulatory approaches in mitigating risks from energy activities also has direct reference and relevance to the pursuit of the Millennium Development Goals from 2000[24] expanded by the 17 Sustainable Development Goals adopted by the UN General Assembly in 2015[25] to cover among other issues energy and the use of natural resources directly. Sustainable use of natural resources and the environmental protection requires the integration of effective compliance policy framework, in particular, with a view to promoting risk mitigation. This in turn, contribute to the pursuit of preserving, protecting and improving among others the prudent and rational utilization of natural

[22]See supra Rozell, D.J & Reaven, S. J. (2012) footnote 20 at p.9.
[23]Ibid.
[24]UN Res A/55/2, United Nations Millennium Declaration, adopted on 18 September 2000.
[25]UN Res A/70/1, Transforming Our World: The 2030 Agenda for Sustainable Development, adopted on 21 October 2015.

resources, and combatting climate which forms the basis for energy justice as a principle of energy law.

1.2 Research Problem

The occurrence of accidents with widespread consequences are inevitable even if there is the exercise of reasonable care for an industry that operates on such a large scale like fracking. The shale gas industry reflects a typical scenario where either the technology has developed fast beyond human capabilities in tackling associated risks or where C&C regulation have proved ineffective in improving compliance to set regulatory standards.

Looking at the regulatory structure for most oil and gas extracting nations, it is evident that the available regulatory and liability regimes could not respond adequately in addressing the science-based concerns about energy development in the energy extractive industry.[26] This alone is a great problem that needs attention if the development of shale gas is to be carried out in a more cost effective and environmentally efficient manner.

In addition, the determination of the level of care required by the courts in the event of harm is still very difficult to achieve. This is borne out of the fact that shale gas development activity just like other sources of energy occurs underground, where only the operator has control over the equipment underground and understands better the complexities involved. Thus, to know what is going on underground solely depends on what the operator decides to reveal. Because of this, a pragmatic liability approach is required to augment the shortcomings in C&C regulation whereby operator may be shielded from liability where they have complied with set standards. However, liability system has its own weaknesses in managing risks associated with energy source development, for example, many operators are small independents whose financial assets may be inadequate to cover all damage awards.

As a result, both regulatory regimes as well as the liability system's applicability in the shale gas development industry needs to be improved upon by addressing some of these weak elements so that each system can play a symbiotic role in addressing recurring risks involved in the extraction of energy resources. Especially, regarding the aspects that has to do with the level of compliance regulated entities should show toward risk mitigation in the energy industry. Compliance with regulatory set standards has become key debate in the energy sector especially as technology is advancing rapidly and the existing regulatory or liability apparatus is not adaptive to the tide of change occurring in the sector. More pathetic is the fact that in instances where full compliance with regulatory requirements is achieved, the policy outcomes is not achieved. These two elements *(compliance and policy outcome objective)* in regulatory design are what forms the bedrock of an effective regulation. For a better illustration of this, see section 4.5.3 in Chapter IV between the case of Amocco Yorktown plant and the U.S EPA where regulation requires that certain technology is to be installed in the smokestack of the plant to reduce benzene emissions level. It was discovered through a later study by an independent party that the smokestack was not where the largest quantity of benzene were being emitted. That Amocco would not have spent the amount of money they used in installing the technology just to comply with such prescriptive traditional regulation. This kind of situation is what necessitates a complementary regulatory instrument mix to ensure full compliance with environmental liability and regulatory standards.

[26]Benjamin, J. R & Stephen, W. (2006). Environmental Law for Sustainability: A Reader. Hart Publishing, Portland, p.361.

1.3 Research Questions

The exploration and exploitation of Unconventional Oil and Gas (UOG) in shale formations through the process of hydraulic fracking technology has raised series of issues ranging from legal, economic, socioeconomic, and environmental to geopolitical within the global energy sector. More so, the entire industry fabric is plagued with contentious dissenting opinions as to whether the process of shale gas development should commence and why it should not. Either way, the commencement or discontinuance of the activity in regions yet to tap into this resource is dependent primarily on building effective strategies for improving the extant regulations on shale gas extraction.

One basic strategy to this end is to formulate a joint system rather than a one-size-fits all strategy. However, to achieve this goal, the following key research question and sub-research questions are crucial to finding a likely route to the sustainable development of shale gas.

The main research question is as follow:

- **Whether shale gas extraction activity should be subject to a strict environmental liability and regulatory regime to achieve a sustainable shale gas development?**

This research will also answer the following two sub-research questions:

1. When should liability be appropriate and adequate, and when is regulation required in mitigating shale gas risks vice versa?
2. What other features should be included in the systems to ensure effectiveness and efficiency in managing shale gas risks?

1.4 Research Aims and Objectives

High Volume Hydraulic Fracking (HVHF) is just like any other oil and gas extractive technique in that it presents a number of negative health and environmental impacts. However, there are some impacts that fracking presents that seem to be quite peculiar to the industry alone. A closer look at the varying opinions regarding these impacts, it suffice to say that hydraulic fracking ought to be properly regulated in terms of the nature of liability of the operator to ensure safe resource development.

In view of this, this thesis aims to discuss on how best to improve the concept of legal liability and regulation as tools for improving environmental requirement compliance. More so, the work is aimed at proposing a *'risk/segment based strict liability rule'* to enforce a systematic behavioural pattern amongst shale gas operators. Contrary to the position of many who have been following the evolving intrigues that has characterised the debate, this work is novel in the sense that it will take further step in distilling the ingredients that illustrate fracking technique as an activity which should warrant a stricter regulatory and liability response in mitigating risks within the context of energy law and policy perspective.

The argument that shale gas should not be subject to a stricter liability regime, shall be weighed against the factors which were promulgated in the various Restatement Acts[27] and compare them with the operation of shale gas fracking activity. A different definition of what an abnormally dangerous activity is from the perspective of the author shall be attempted relying on the concept of what the author terms 'transgenerational harm' and the frequency of risks occurring theory. The focus of this thesis is to develop framework policies to further improve compliance through liability and complementary regulatory systems to promote an

[27]See Restatement (Third) of Torts: Liability for physical & emotional harm (2010); Restatement (Third) of Torts: Apportionment of Liability. (2000); Restatement (Third) of Torts: Products. Liability. (1998).

effective and efficient means of mitigating shale gas extracting risks associated with slick-water hydraulic fracking technology.

In sum, the objective is to steer regulated entities in the energy industry towards public policy objective in mitigating risks resulting from extractive activities in the most effective and efficient way that compliance and policy outcomes is achieved, without necessarily distorting greatly with corporate autonomy and profit. Once this kind of regulatory framework is promoted, the syndrome of fruitless expenditure of government and business resources on traditional C&C styles of regulation that ignore the effects of self-regulatory orderings is addressed. The success of self-regulatory and strict liability systems as environmental regulatory and liability tools is strongest in environmental, occupational health and safety and financial services regulation.[28]

1.5 Hypotheses

Both liability and regulatory systems have been designed as environmental and health protective tools in industrial societies. However, these systems have witnessed divergent interpretation and application. As such, this thesis shall consider two thoughts that explore in detail the various arguments as to their appropriateness to address environmental and health risks in certain situations. This will be done in-order to develop the ideal hypotheses for the reader to follow the entire structure and objective of this thesis. The key question of whether fracking is an abnormally dangerous activity for the purposes of warranting a critical appraisal of both liability systems appears to be based on certain legal policy requirements. This big question turns on a smaller one: whether accidents in fracking are avoidable or unavoidable. These hypotheses shall be based on two thoughts:

The Rationale for Stricter Liability and Regulatory Application:

Indeed, different thoughts exist regarding the application of stricter liability and regulatory policy analysis by the courts. A judge postulates that the essence of strict liability is to compensate the plaintiff in situations where negligence cannot address the claim in that 'causation' as a legal prerequisite is difficult to prove.[29] Other scholars have argued for a more liberal use of stricter liability regimes. In fact, one commentator vehemently suggested that the high transaction costs in incidents characterised by low losses and the interactive situation should form the only two reasons for rejecting a more inclusive liability application.[30] The issue of a more guaranteed accountability for accidents has formed part of the reasoning why some advocate for a stricter liability regime widely in contrast to strengthening the existing regulatory institutions for the task of managing environmental and health risks accordingly.[31]

Moreover, the concept of a liability system, boxes "rational actors" who will bear the cost of harms that they cause into taking all cost effective precautionary measures that are within their reach to economise on liability.[32] Thus, a party who is held strictly liable for harm caused by his or her actions is then forced to make efficient and dynamic market decisions so as to

[28]Aalders, M & Wilthgaten, T. (1997). "Moving beyond command and control: Reflexivity in the regulation of occupation health and safety and the environment" *Law & Policy* Volume 19. pp. 415-443.
[29]William, L. P. (1953). The Principle of Ryland V. Fletcher. In: selected topics on the law of torts 135, 147 (Judge Posner made the comment also made the statement).
[30]William K J. (1992). '*Strict Liability for Hydraulic Hazardous Enterprise', 92* Colum. l.Rev. 1705, 1709; Ryland V. Fletcher, L.R. 3 H.L. 330 (1868) (Detailing how Ryland established the strict liability doctrine) at p.1754.
[31]Ibid at p.1753.
[32]Alan, O. S. (2007). 'Strict Liability versus Negligence in Indiana Harbor', 74 u. Chi. l. Rev. 1911, 1918 at p.19.

internalise the cost of the damage incurred by its risky activity.[33] Several scholars believe that, unlike regulation, holding operators in shale gas extraction strictly liable for water contamination is more effective in deterring socially harmful conduct. Hence, the concept of strict liability should be invoked and applied mostly during water contamination accidental injury.[34]

The allocation of risk principle[35] is another rationale for the liberal application of a more inclusive liability system under these hypotheses. The risk principle is based on fairness in that if the party thinks that it is appropriate to create an abnormal or undue risk of harm to members of particular community, it is also appropriate that that party is strictly made responsible for any harm caused.[36] More importantly, stringent liability regime creates room for the actor to avoid accidents by foreclosing any opportunity for defence an actor may hide behind.[37] This foreclosure, forces the actor to experiment with methods aimed at preventing accidents prior to the commencement of the activity. Such experimental methods could include relocating from earlier intended sites, changing, or reducing the activity causing the accident.[38]

Given these rationales for the proposition of pragmatic policy options for developing a liability and regulatory systems to reduce the occurrence of harms from HVHF technology, two key hypotheses are made:

- That achieving the required state of change (successful transformation from frequently occurring risks in energy extraction to an acceptable level) that the present industry requires, will continue to be far-fetched if attempts at managing these challenges remain focused on the bane of improving weak regulatory institutions and the incorporation of Best Available Techniques (BATs) to resource extraction among others, to the exclusion of the problem of applying a more holistic approach including stricter liability, regulatory measures and policy interventions as an undoubtedly strong governance structure for risk mitigating mechanisms so that industry can regulate themselves to an extent.
- That the challenges of the HVHF technique can only be addressed if strong liability regimes are established to govern the operations of actors in the industry to the point that: (1) the choice of ensuring safety is in-built into the system such that it is the actors themselves that decide particular locations that are fit for fracking activities instead of relying on BATs which may not be ideal for particular activity. This is because they were formulated from activities which do not bear direct relationship to fracking sometimes; and (2) actors of such abnormally dangerous activities are not incentivised to pay for the cost of damage but are forced to adopt effective measures to forestall such risks from occurring regularly or completely avoid them.

[33]Nathan, R. H. (2010). 'The feasibility of applying strict liability principle to carbon capture and storage', 49 Washburn L.J. 527, 537-38 at p.539.
[34]U.S. Department of Energy., (2004). 'Hydraulic Fracturing White Paper A' -1[hereinafter doe white paper 2004], at p. 1709. [*Online]* http://www.epa.gov/ogwdw/uic/pdfs/cbmstudy_attach_uic_append_a_doe_whitepaper.Pdf. (Accessed 02/2/ 2017).
[35]Norman, J. H. (2001). Nontechnical Guide to Petroleum Geology, Exploration, Drilling, and Production (2nd Ed) 423–24 at p.538.
[36]Ibid at pp.538-9.
[37]See Indiana Harbor Belt R.R. Co. V. Am. Cyanamid Co., 916 F.2d 1174, 1177 (7th Cir. 1990).
[38]Ibid.

Accordingly, the first hypothesis creates a point of departure that guarantees a self-regulatory mechanism into the industry that ensures that industry actors themselves are responsible for making the right decisions to ensure the avoidance of risk of harm that characterise such economic activities like shale gas fracking in the energy industry. The actors do the investigations prior to the commencement of the activity instead of relying on external regulatory institutions who may not adequately understand the complexities involved in handling the technical safety of the operations in Unconventional Oil and Gas Extraction (UOGE) through hydraulic fracking technique. The second hypothesis authenticates the push for a stringent liability regime (strict) on one hand. On the other hand, it eradicates the rationale put forward by opponents of the principle that one may not know the complexities involved in a new technology like fracking since it has not been given an opportunity to operate before campaigning for a complete ban of the activity. The industry is relatively as old as the present wave of industrialisation in the world at large. It would be misleading to assume that the impacts of shale gas extraction cannot be categorised as abnormally dangerous when it is weighed against other negative risks that emanate from other extractive techniques. This leads to the conclusion that building a very robust liability and regulatory system transforms the complexities involved in new technologies that threatens the health and environmental needs of any resource rich nation.

1.6 Significance and Contributions of the Study

One important issue facing modern societies is how to avoid severe, presumably cataclysmic, harm to the natural environment. The reasons behind such harm are not only complex but controversial, and they arise from a wide spectrum of economic and social pressures. The results are evidenced in the apparent pollution, land degradation, deforestation, ozone depletion, climate change, and the loss of biological diversity which creates severe and, in some cases, transgenerational impacts to the planet that is required to sustain us. Consequently, it has been argued that the window of opportunity to avert these ecological disasters is rapidly closing in, and that in some cases, it may already be too late to prevent ongoing health implications and environmental degradation.[39]

One solution to manage these severe risks associated with resource extraction from energy law and policy perspective is to strengthen regulatory strategies that ensures a higher level of compliance to regulation and promote the ideal for operators to internalize the cost through a stricter and robust liability regime.[40] However, in today's world, all indices point to the fact that recent technological advancements have presented a situation where direct regulation can no longer adapt to the changing dynamic of technology in several fields of discipline. One area where this miscarriage is so evident is in the extractive industry. Regulation is said to have been operating from a distance rather than taking the centre stage in mitigating the attendant risks. More pathetic is the fact that companies, and not regulators, decide on the details on safety governance, production technology, and quality of product.

The issue of information asymmetry has been the fundamental reason behind this twist in the governance of safety and quality of production technology in the shale gas extractive industry. This invariably leads to the ineffectiveness seen presently in today's regulatory environment surrounding energy extractive activities. Given the room to re-regulate, how can we attempt to further strengthen the effectiveness of regulation without forfeiting the benefits

[39]Selcuk, B & Ikbal, S. (2016). 'New horizon in energy': Shale gas. *Journal of Natural Gas Science & Engineering* Volume 35, Part A.

[40]Aven, T & Ylonen, M. (2014). 'Safety regulations: Implications of the new risk perspectives. *Reliability Engineering and System Safety,* Volume 149*,* pp.164-171.

resource extraction activity offers? Put another way, how can we re-regulate to balance the conflicting needs between what is beneficial to society and what is beyond the socially optimal level of harm to the same society? These underscores the significance of this research.

To deal with these questions, it is the assumption of this thesis that regulation can be more effective and improved upon if it does not neglect the strategic regulatory approaches which will force the industry to self-regulate. This is important because indirect control otherwise known as self-regulation is compatible with controlling dispersed harms associated with highly risky outcomes that characterize energy extractive activities. It is also ideal in that it reduces the uncertainty in immature technologies as well as addressing the asymmetric information syndrome prevalent in resources extractive technologies. These problems provoke a strong incentive for regulatory subversion or capture by the operator.[41] Thus, one way to achieve an indirect control through regulation is to impose stricter environmental liability measure using the 'risk based strict liability rule' formulated in this thesis. Particularly, this will help in mitigating the increased frequency of risks identified in shale gas extractive activity.

Given these advantages, how can environmental regulation overcome the shortcomings inherent in indirect or self-regulatory approach in mitigating risks associated with resource extractive technique like fracking? Unlike other scholars[42] that have proposed or argued vaguely that regulators could better manage the risks to water contamination from fracking activities by strengthening regulatory safeguards, incentivising research, clarifying tort responsibility and using insurance mandates to ensure compensation and remediation.[43] This thesis proposes indirect regulation or self-regulatory approaches through specific strategies to overcome the shortcomings of direct regulatory approaches suggested to mitigate the risks of dispersed harms.

Again, considering the widespread ban on fracking technology within States in the U.S[44] and within the EU due to its environmental impacts, this thesis aims to develop a framework that will strengthen the entire gamut of energy law and policy in regulating risks to a socially optimal level. Also, it precludes the operator of a dangerous activity to be shielded from liability simply because he has adhered to the prescribed best practices or regulatory requirements. On the reverse side, operators of shale gas activity will be given the social license to operate as members of the public are quite confident that justice would be done if harm occurs by eroding the difficulty in proving the liability of the operator.

Prior efforts to mitigate certain risks associated with extractive activities through regulation and liability fell short in capturing the effectiveness required for achieving a socially optimal level of harm. For example, Shavell Steven in his work [45] clearly outlined the issues that confronted the tasks of mitigating risks. Such issues include: information asymmetry; inability of a judgment debtor to pay; the cost involved in suing an alleged defaulter; and threat to suit. He vehemently argued that the issues of energy and environment are fundamentally entrenched in an indissoluble nexus with multiple dimensions that, in turn,

[41]Ibid at p.279.
[42]Cecot C. (2016). 'Fractured Systems: A Multiple Policy Proposal for Promoting Safe Shale Gas Delivery in the United State' In: Raphael J. Heffron & Gavin F.M. Little (2016). Delivering Energy Law and Policy in the EU and US: A Reader (ed), Edinburgh University Press, United Kingdom at p.334.
[43]Ibid.
[44]Loftis, R. (2013). Dallas Oks gas drilling rules that are among the nation's tightest' Dallas News. [Online] https://www.dallasnews.com/news/news/2013/12/11/dallas-oks-gas [Accessed 08/08/2017].
[45]See supra Nathan R. H. (2010) footnote 33.

exert asymmetric influence over divergent stakeholders and settings and occur at different spectrums and physical scales. Having done that, Shavell did not take a definite stance on the issue of the best tool between liability and regulation in mitigating risks associated with resource extraction.

Rather he proposed a combination of both by highlighting the merits and demerits in both tools. Also, Caroline Cecot in her article '*Fractured Systems: Multi Policy Proposal for Promoting Safe Shale Gas Delivery in the United State'*[46] clearly toed the line of argument by proposing multi policy strategies. The work identified the use of liability, regulation and financial liability schemes such as the establishment of "Superfunds", which obligates operators to contribute to the fund. In her recommendations, she suggests that operators with the greatest default should be made to contribute more. However, their work did not contain specific strategic policy options that might address the issues of dispersed harms that are associated with shale gas fracking just like every other energy extractive activity. Further, they[47] did not clearly recommend a system that would strengthen the effectiveness of regulation by ensuring compliance without the regulatory institution closely monitoring the operators of such risky activity. It is based on these overarching premises that this thesis builds upon, to provide specific policy options that might help to address the asymmetric influence over diverse stakeholders as prevalent in the industry. Furthermore, this thesis seeks to add to the collection of solutions Shavell proposed for each of the problems that confronts regulation and liability systems. Thus, the thesis contribution to the available literature regarding safe shale gas extraction has the following ramifications discussed below.

This research argues for a combination of policy proposals for strengthening the existing regulatory system. Specifically, the work proposed and agreed with some of the suggestions of scholars that for there to be a reduced level of risks, regulators need to clarify tort responsibility. This is true because stricter measures of liability forces the operator to devise internal management arrangements to reduce risks that are highly probable to occur. It makes them go beyond the regulatory set standards and best practices that are applicable in the energy industry. However, this thesis seems to be quite bold in arguing for a strict liability to be applied to fracking risks where water contamination claims is involved by adducing evidence that suggest that this is the most prominent risk. The legal rationale for this is anchored on the argument that water contamination risks have an increased frequency level of occurrence. Also, on the premise that water is a special commodity which ought to be protected in line with the objective of the United Nation (UN) Millennium Development Goals.[48]

More so, energy development is the most rapid growing consumer of water in the US.[49] And any attempt to prioritise gas as an energy source over water means that the very essence of living would disintegrate as the status of water and energy are distinct and contribute immensely to the aspects of the UN Sustainable Development Goals (SDGs). Therefore, if strict liability is applied to water contamination claims, it would make operators to be more certain before introducing technologies which have great and transgenerational negative impacts to society.

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[46]See supra Loftis, R. (2013) footnote 44.
[47]See Aven, T; & Ylonen, M. (2014) foot note 40; Caroline Cecot (2016) foot note 42.
[48]Dorling, D. (2013). Population 10 Billion: The coming demographic crisis and how to survive it. United Kingdom, Constable and Robinson Ltd Press.
[49]United Nations (2014) 'Water and Energy'. *The United Nations World Water Development Report* Volume 1, [Online] http://www.unesdoc.org/images/0022/002257/2254741e.pdf (Available 20/07/,2018)

Furthermore, this thesis makes a novel contribution on how to solve the issue of liability claims when it comes to dispersed harms from oil and gas extractive activities like shale gas. Dispersed harms from extractive activities presents a situation where potential plaintiff(s) are unable to sue a defendant-operator(s) as they often find it difficult in identifying the actual defendant that caused their injury. This indirectly gives the operator the incentive to continue the polluting act. Some of such dispersed risks could be air and groundwater contamination. This thesis contributes by specifically identifying the independent segregated licensing scheme to address this difficulty faced by potential plaintiffs. By this, this thesis sets out that when issuing licenses for exploration and extraction of hydrocarbons, the relevant licensing authority should designate a large area to an individual licensee where by other license holders can trace their rights to the original license holder. So, in the event of a dispersed air or groundwater contamination where the source is unknown, it affords the plaintiff to sue for liability claims connecting that harm to the original license holder. This resonates the joint and several liability rule under tort law and thus clearing any ambiguity surrounding the perpetuator of the alleged harm and addressing the 'threat to suit' problem inherent in direct forms of regulation.

This thesis made another contribution in addressing the information asymmetry syndrome and the inability to pay/judgment proof defendant problem which accounts for the regulatory subversion or capture and the shortcoming of liability systems in mitigating risks by suggesting self-regulatory policy interventions. To address the information asymmetry, each well should have an 'independent well assessor' whose responsibility is to report directly to the regulatory institution. Whereas, a model known as the 'Polluter Does Not Pay' is proposed to tackle the inability to pay/judgement proof defendant. How this works is that the plaintiff who is unable to recover in damages against the defendant because the defendant's available assets cannot cover the judgement sum, the plaintiff can recover same from the government who in the first place gave the judgement debtor the license to engage in the activity that caused the said harm. This model will only work for most legal systems where the ownership of mineral rights resides with the government. The government in turn may recover same from the mother-company or benefit from the insurance or bonding cover in place. For detailed discussion, see Chapter V under sub section 5.3.

1.7 Methodology

A comparative study on shale gas extraction activity's and its associated risks is adopted in this research. The focus of this research is to promote the effectiveness of environmental regulation and liability in mitigating such risks. This thesis complements the existing initiatives and strategies to enhance synergies and encourages coordination in the implementation of regulatory requirements; and reinforces the connectivity struck between regulation and liability systems.

1.7.1 The Single Case Study Approach

Researchers often run into the risk of contradiction whilst embarking on case study research. This can be further exacerbated by the varying legal, economic, cultural and socio-economic variables existing in each selected case study. In other words, what might apply for A to achieve success can be remarkably different for B. Therefore, scholars end up making assumptions instead of arriving at a definite solution to address a particular existing problem.

Conversely, in a single case study methodology in research, that particular country example is explored and examined. All the factors that accounts for either the success or failure of that system in that single jurisdiction is peculiar to that region alone. Thus, it makes it easier for countries to study that country in question by looking for similarities and differences where

necessary. Once, these similarities are found it would be either easier to replicate the same level of success or avoid the errors committed by the other country.

Also, single case study research methodology provides the opportunity for change in the positive direction by the other party who intends to adopt or reject the lessons drawn from the case study before it goes beyond the capabilities of the country seeking to apply the outcomes from the sister country. These makes single case study approach in research methodology important especially in the energy resource extraction industry that is more susceptible to frequent changes. However, single case study research forecloses the opportunity for a different analysis to be explored that have similar intervening indices. This is crucial because the opportunity for changing the course of event is totally jeopardized as multi case study approach might expose new adaptive ways of resolving issue(s) which single case study approach would not have revealed in the first place. This is a fundamental weakness of a single case study research methodology.

Having said that, it is important to quickly give a brief overview of the U.S context in terms of energy related matters and why this thesis chose to focus more on U.S regarding the discussions on shale gas extraction risks. The reason is quite simple. The U.S is the first country that took the bold step in introducing the technology used for extracting these unconventional oil and gas resources. Also, the literatures reveals that indeed success have been recorded as well as failures. In addition, the U.S mineral rights is such that attributes autonomy to individual states to regulate the activities of oil and gas extraction within their territory with the exception of federal lands. Thus, there seem to be wide spectrum of complexities because of the nature of legal regime that regulate energy resource extraction for which shale gas plays a part. Each state have different regulatory approach that govern them. This in itself, makes it quite interesting in choosing the U.S and its states as a case study in this thesis.

More importantly the U.S is being used as a case study because of the autonomy each states has in making their own environmental regulations and environmental protection programmes applicable to the oil and gas sector. The unique phenomenon about the laws in each states' environmental programmes are often influenced by several factors ranging from the economic positions of individuals and the educational standing as well as the financial capability of the citizens. These factors account for either the severity or otherwise of the nature and type of environmental protectionist measures adopted by the regulatory bodies. However, the EPA play a major supervisory role regarding these diverging environmental programmes to create some level of harmonization of legal laws operating in the U.S or within lands jointly controlled by state and federal government.[50]

Also, the U.S is used in this study as a case study because evidence shows that it is an influentially inclusive centre for the proliferation of effective regulatory compliance programmes for risk mitigation within the energy and larger corporate outfits.[51] A survey of Canadian companies revealed that companies operating in Canada with a U.S parent company were much more likely to have a larger number of elements of an effective regulatory compliance programme instituted such that U.S owned companies averaged 6.6 out of 9

[50]Cook, F. J. (2014). Who's regulating who? Analysing fracking policy in Colorado, Wyoming, and Louisiana. Environ. Pract. Volume. 16, p.64-67.

[51]Schwartz, M. (1998). "Compliance and business ethics are coming of age I Canada" Ethikos & Corporate Conduct Quarterly, Volume 12(1) pp.7-9, 12.

elements of the regulatory compliance programme while Canadian owned enterprises averaged only 3.5 out of 9.[52]

1.7.2 Comparative Legal Analysis

Prior to this time, comparative legal research was viewed by some as mainly as an instrument for improving domestic law and legal doctrines, as a way to renovating the old approach of the still dominating Exegetic School to the Civil Code and its interpretation.[53] Comparative legal analysis became fashionable in that it became the necessary instrument for a desirable harmonization of law around Europe and beyond by the end of the twentieth century.

Hence, according to the circumstance, comparative legal analysis as a method in research evolved with different aims and divergent reasons for comparing legal systems. Thus, comparing legal systems was not only the area that forms the basis for embarking on legal analysis. Scholars now saw the need to incorporate other areas such as the comparison of the economic factors; government policies on aspects of governance and regulation and the behavioural aspects of firms operating within one country to another on how they influence the overall decision reached on an identified problem.

Having said that, it is pertinent to note the key aspects for comparative legal analysis. Comparative legal research analysis is seen as an instrument of learning and knowledge (information on the law elsewhere and a better understanding thereof). Comparative legal analysis as an instrument of evolutionary and taxonomic science. Comparative legal research contributes to one's own legal system (understanding it better, including the resistance of its traditions, improving it, and using it as a means for interpreting the constitution). Comparative legal analysis as an instrument of harmonization of laws and regulations.[54]

To this end, this thesis seek to compare the state policies and laws designed to mitigate prospective environmental impacts associated with U.S oil and gas drilling fracking operations. Particularly, to embark on a comparative legal analysis of the characteristics of oil and gas producing states that have enacted policies designed to mitigate prospective environmental impacts associated with fracking operations. Secondly, to examine the applicable environmental liability and regulatory regime designed in various oil and gas producing states to mitigate environmental issues relating to gas fracking. Charles Davis in his 2016 article titled "*Fracking and environmental protection: An analysis of the U.S. State*"[55] shares similarity in terms of the object for a comparative legal analysis. After briefly comparing the regulatory context of fracking regulations and legal environmental liability regimes in some states in the U.S, this thesis argued using the factors as stated in the Restatement (Second) Torts as a basis in arriving at the conclusion as to why a stricter liability rule should be applied to water contamination claims as well as formulated strategic legal policy options that would foster self-regulation for achieving some form of rational behaviour amongst operators in the energy industry.

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[52]Ward, A. (1997). "Compliance Surveys: Compliance say better safe than sorry" *Corporate Legal Times,* Volume 62(7), pp.1-3.

[53]Sacco, R. (1991).'Legal formants a dynamic approach to comparative law' *American Journal of Comparative Law* p.1-34 (part I) and pp.343-401 (part II).

[54]In the Elgar Encyclopaedia of Comparative Law (Glenn 2006). Compare the purposes of comparative law research' as listed by Esin Orucu (2007, p.53-56).

[55]Davis, C. (2016). Fracking and Environmental Protection: An analysis of the U.S. State, *The Extractive Industries and Society,* [Online] www.elservier.com/locate/exis (Accessed on 21/11/2018).

1.7.3 Stages of Research

The expectation of this thesis is to extend the deterrence effect of environmental regulation and liability systems to a point where industry will self-regulate. The method of research engaged in this thesis is tiered; and systematically developed through a case study and interpretation of established legal principles and rules. The stages of the methodology developed include:

Examination of what HVHF is about and its associated impacts as well as the various forms of fluid based fracking techniques.

A descriptive approach will be undertaken to highlight how fracking operates and the components of the associated risks as it relates to environment and health. The issue of water contamination among others is identified as a unique risk because of its highly probable level of occurrence. This discussion gives credence to the argument as to why strict liability should be applicable to water contamination cause of action. The relevant forms of fluid based hydraulic fracking technique will be identified and elaborated. The issue of 'cost effectiveness' factor will be advanced as an argument that compelled industry to choose the applicable slick-water hydraulic fracking technique amidst better options.

Definition of principles and identification of legal principles and the interaction between regulation and liability systems.

The definition of certain applicable legal principles as they relate to risk mitigation will be studied. The need for regulating shale gas extraction, alternatives to regulation and the relationship between the core ingredients of liability and regulation will be studied. This stage also determines the normative alternative to regulation and the benefits and criticisms of liability regimes whilst contrasting that with the limits of safety regulation in the field of risk mitigation mechanisms. This stage is equally crucial in illustrating that shale gas fracking activity and its associated risks reflects an abnormally dangerous phenomenon based on the Restatement (Second) of Tort.

Justification for implementation of policy options for mitigating shale gas extractive risks.

This stage is important in illustrating the policy, social and regulatory concerns for allowing shale gas extraction. The inherent difficulties in some theories of law determining where defendant's liability lie to give justification for a strict liability as well as the relevant policy options will be discussed in this stage. This stage will make a strong argument in favour of the viability for strict liability to govern fracking claims. This will be upon the conclusion that fracking is an abnormally dangerous activity having compared the requirements of Restatement (Second) of Tort.

Identification of the environmental regulatory and liability problems.

This stage highlights the problems embedded in regulation and liability systems that make them ineffective in managing the attendant risks from fracking. It sets the foundation for the policy options that will be put forward in this research. This thesis will comparatively begin by examining the similarities and differences in the technique used for extracting oil and gas from conventional and unconventional well. In addition, this thesis will analyse the impacts it poses to the environment, identifying water contamination as one unique risk different from conventional gas extraction.

The USA oil and gas laws applicable to shale gas extraction will be compared with other countries currently nursing the idea to extract their shale gas deposits. The similarities in terms of weakness and strength will be explored. Particularly, the EU shale gas legal framework and

some member states within the EU will also be examined. More so, the factors that are responsible for the success of shale gas development from the U.S will be comparatively weighed against the dynamics within the EU.

Consequently, a critical comparison will be conducted into the 'pros' and 'cons' of both regulation and liability. The Restatement (Second) of Tort criteria for determining what an abnormally dangerous activity is. This will be weighed against the risks of shale gas extraction. This thesis will then compare some common law principles to show the difficulties in proving defendant's liability against present fracking risks. This exposition is meant to provide justification for a strict liability system for water contamination claims.

Since the entire work is about devising a framework for environmental regulation and liability to strengthen the principles of energy law and policy, this thesis will embark on a systemic comparison of both strategies for risks mitigation, namely how each problem affect regulation and liability. This thesis will suggest concrete policy directions to address these problems for the required effectiveness. The methodology developed informs the justification for a complementary approach through policy measure to achieve effectiveness for risk mitigation that provides the structure in which the research questions in this thesis will be explored and answered.

1.8 Limitations of the Study

Shale gas controversies are focused particularly around the U.S experiences where several factors such as: the nature of mineral right and geographical locations of these resources has contributed to the huge successful exploitation. Thus, this research takes a cue from the cases surrounding shale gas development in the U.S and that of the European region where countries like France and Bulgaria (at the time of writing this thesis) issued moratorium regarding the possible exploitation of shale gas.

Therefore, because the case study of shale gas is concentrated around one country with regard to what is ongoing, that is, the U.S, it resonates one of the major limitations of case study research as posited by Robert Yin in his book titled *Case Study Research: Design and Methods.*[56] He said: "*a single case study research presents the absence of systematic procedures due to a relative absence of methodological guidelines"*.[57] Thus, the reader will only have examples of such regions where the development of shale gas operations has been explored or is currently undergoing production.

Second, the fact that shale gas development operations through the introduction of novel aspects of HVHF technique is quite new, for example, the slick water technique. Hence, the issues are new and controversial within the energy resource industry. And because of the conflicting interests involved, there is no clear-cut position regarding any issue amongst opponents and proponents of fracking techniques in general. Therefore, this study is limited in the sense that what might be correct might change tomorrow based on future findings which might be scientifically proven. Due to this, the reader is advised to have a very open mind set while approaching all works relating to shale gas development through hydraulic fracking as they may be subject to very rapid changes.

More so, this article might well be limited in that it assumes that the ability of operators in risky activities to act rationally may be triggered by deploying the utilities of self-regulatory strategies. Although, studies on human behaviours have shown clearly that apart from the fact

[56]Yin, R. K. (2009). Case Study Research: Design and Methods. (5th edition) SAGE Publications Ltd: London, p.14-15.
[57]Ibid at p.14-15.

that humans have the ability to influence their own well-being, they do not have that same cognitive ability to influence the direction of their actions and decision all the time.[58] Certain factors are also responsible in playing a role in either making an individual act rationally or irrationally in complying to set standards meant to regulate his behaviour in the long run.

From a policy and regulatory stand point, this thesis assumes that improving a rational behaviour with the energy industry in terms of achieving full compliance through effective regulation, human participants should be allowed to take part in regulatory decisions. This is important because no matter the best regulatory structure in place, humans will forever be bent on improving their condition in an agentic way.[59] This inherent state of mind of the individual is what makes them self-regulators. Therefore, this is the very basis for the root meaning of "rationality." In fact, this thesis concludes by assuming that when we speak of rationality we should actually refer to self-regulatory process. Hence, it is the position of this thesis that if self-regulatory strategies and internal management standards in conjunction with traditional C&C regulation are deployed in regulation, actors within the energy industry will be rational in complying with the set regulatory requirements in mitigating risks from resource extraction.

Thus, in environmental issues, we need to understand that we cannot convert human beings into model people to do the right thing. However, policy makers can leverage on the power of regulation and strategies to make right decisions which are self-sustaining and has the ability to create incentives for people to be rational.

Another limitation of this thesis is that the researcher might end up presenting a subjective argument based on logic and reasoning[60] on the issues to be addressed in order not to take side with either the proponents of fracking or opponents. There are no contradictory process tracing results.[61] Also, the researcher rests its arguments on certain assumptions that can raise deeper and potentially irreconcilable issues.[62]

Furthermore, there is the issue of external validity or generalisability. This qualifies as one of the major criticisms of a single case study research. This is an unavoidable valid criticism because it may be that theories which passes a single crucial case study test, for example, a rare antecedent, have little explanatory range.[63] Case studies provide a means to investigate complex situations with multiple variables under analysis. Case studies are particularly appealing for advancing a field's knowledge base. They are very popular in the fields of applied sciences in the areas of social sciences, education and health.[64] Case studies offer a good opportunity for innovation and challenge current theoretical assumptions. They can also be a good alternative or complement to the focus group method. However, it can be difficult to

[58]Bechara, A & Damasio, A.R. (2005). "The Somatic Marker Hypothesis: A Neural Theory of Economic Decision Making." Games and Economic Behaviour 52, no. 2: 336–72.
[59]Baumeister, R. F. & Kathleen D. V. (2007). "Self-regulation, Ego Depletion, and Motivation." Social and Personality Psychology Compass 1, no. 1: 115–28.
[60]Verschuren, P. J. M. (2003). 'Case study research strategy: Some ambiguities and Opportunities', *International Journal of Social Research Methodology*, 6, 2, 121-139.
[61]Owen, J. M. (1994). 'How liberalism produces democratic peace', *International Security*, 19, 2, 87-125; Layne, C. (1994). 'Kant or Cant: the myth of the democratic peace', *International Security*, 19, 2, 5-49.
[62]Bennett, A & Elman, C. (2007). 'Case study methods in the international relations subfield', *Comparative Political Studies*, 40, 2, 170-195.
[63]Van, E. S. (1997). Guide to methods for students of political science. *Cornell University Press:* Ithaca.
[64]Atieno, O. (2009). An analysis of the strengths and limitation of qualitative and quantitative research paradigms. Problems of Education in the 21st Century, Volume 13, pp.13- 18.

establish a cause-effect connection to reach conclusions and it can be hard to generalize, particularly when a small number or case studies are considered.

Field research allows researchers to have a depth perception about people and processes. The collection of data is done on the field and it can occur over an extended period of time. As stated by Blackstone (2012)[65] social facts may not appear and be revealed to a researcher in a first moment, but they can be discovered over time during the course of a field research project. Field research is an excellent method for understanding the behaviour of people and their experiences. However, it is not easy to generalize this approach to a very large number of people or groups, and documenting observations may become a challenging process. This research did not carry out frequent field trips to shale gas sites as these sites require a lot of permits. As a result, the research had to rely solely on research narrative from library and online sources to make certain inferences in the thesis and the conclusions on certain issues raised.

1.9 Structure of the Thesis

As this work is about analysing and devising an environmental regulation and liability framework for mitigating risks in the ambit of energy law and policy. However, it important the reader has an overview of each Chapter. Thus, Chapter II provides an in-depth literature review on the various contributions made by scholars regarding regulatory reform for an effective risk governance and mitigation strategy. It divided these contributions into three broad segments for easy understanding: by institutions; academics; and shale gas specific regulatory reforms. Chapter III generally describes what hydraulic fracking is by examining the various stages from drilling to actual production and further explores the health and environmental impacts associated with fracking ranging from water quality and contamination to impacts on people, communities and climate change. However, in the same Chapter III, it argue that water contamination is a unique risk to fracking since the frequency with which they occur is quite different from conventional natural gas activities.

Under water contamination risks, this Chapter broadly categorised these water risks into four namely the drilling and fracturing fluid as the first risk. Such fracturing fluid risks could arise from migration of fracturing fluids caused by subsurface cracks or surface spills or flow back as a fracturing fluid risk. It could be as a result of cracked well casing or blowouts. The second category of risks relating to water contamination can arise from contamination of groundwater well Aquifers with methane contents. Sludge and other residue disturbances in wells due to fracking could be the catalyst for this water related risk.

Fourth, the injection of fracking fluid waste and produced water into injection wells and sewage facilities could be the result of risk relating to water contamination. Chapter III concludes by identifying other forms of fluid based hydraulic fracking techniques by exploring the advantages and disadvantages of each.

Chapter IV commences with a broad background definition to two key concepts and principles: The concept of regulation and the principle of liability is defined. This Chapter examines some principles of regulatory design. Carefully identifies factors that necessitates the need to regulate shale gas extraction activity. The limits to safety regulation is also analysed, along with identifying the issues of technological innovation leading to outdated

[65]Blackstone, A. (2012). Principles of sociological inquiry: qualitative and quantitative methods. [Online] https://2012books.lardbucket.org/books/sociologicalinquiry-principles-qualitative-and-quantitative-methods/index.html (Accessed 24/08/2018).

regulation, regulator's lack of information on risks, regulator's lack of information on costs and benefits and regulatory capture or subversion to mention a few as factors limiting regulatory efficiency. Similarly, the thesis explores certain alternatives to regulation in sub section 4.3.2. These alternatives range from market-based regulation to self-regulation. Liability as a system for environmental protection in conjunction with innovative policy options is analysed as a complement not as a substitute for regulation. Further, this Chapter reviewed both regulation and liability systems by identifying certain indices that account for their ineffectiveness, the benefits and negative criticisms of each of them. The Chapter rounds off by analysing the six factors contained in Section 520 of the Restatement (Second) of Tort Act[66] to buttress the argument why shale gas should be classified as abnormally dangerous activity based on the *increased frequency and transgenerational theory* to subject fracking stricter liability regime and the strategic policy options recommended by the work to improve the effectiveness of both environmental regulation and liability.

In line with factors (a) & (b) which talks about great harm and high degree of risk. The work took note of the number of accidents that had taken place since the commencement of shale gas within US. It was revealed from the available statistics that from 2009 to 2012, over 30 cases were filed in court regarding shale gas claims. The Court within the U.S reported over 1000 issues of contamination alone.[67] The thesis also examined water as a special commodity to mankind and if contaminated may not be redeemed even with the most sophisticated technology. This work stressed the issue of water contamination as the most devastating and frequent risks associated with fracking. A quick analysis of how shale gas water contamination risks could be frequent is needed here.

For example, to identify potential scenarios of concern regarding human health risks surrounding the natural gas drilling industry a survey of industry workers and regulators was developed and implemented to quantify the frequency of failure incidents and near-miss accidents at the wellhead site. The goal of the survey is to better understand scenarios of concern for human health risks as a result of operational failure incidents and regulatory violations during natural gas drilling in the Marcellus shale region in the state of Pennsylvania. Thus, an elicitation of health perceptions regarding unconventional shale gas development in the Marcellus region found that 22% of the 72 respondents perceived unconventional drilling as a health concern, while 42% attributed health symptoms to environmental factors, the most frequently selected of which was unconventional drilling activities.[68]

Also, to further illustrate to the reader the frequency level of shale gas incidents to justify for a strict liability regime, a study conducted by Vengosh *et al.,* in 2014[69] regarding contamination risks to water sources. The study identified four scenarios where these risks can occur from shale gas extraction: stray gas leaking into shallow aquifers, surface water contamination from spills and leaks, soil and river sediment contamination from wastewater, and the overuse of freshwater for hydraulic fracturing.[70] These four scenarios is only related to water contamination risk. This accordingly, resonates a high frequency level of risk resulting in water contamination issues. This is why this thesis proposed for a 'risk/*segment based strict liability*

[66]Restatement (Second) of Torts § 520.
[67]Barclay R. N. (2014). Report on the Statistical Review of Frack Accidents in the U.S.A [Online] http://www.smart.com/Find/HydraulicFracking (Accessed on 23rd July 2018).
[68]Saberi, P. *et al., (*2014). Field survey of health perception and complaints of Pennsylvania residents in the Marcellus Shale region. *J Int J Environ Res Public Health. 2014 Jun; 11(6):6517-27.*
[69]Vengosh, A. *et al.,* (2014). A critical review of the risks to water resources from unconventional shale gas development and hydraulic fracturing in the United States, *Environ Sci Technol*. Volume 48, Issue 15, pp. 8334-48.
[70]Ibid.

rule.' By this, the thesis means that where particular risks relating to an activity is frequent in their occurrence, those risk should be subject to a strict liability claim under the segmented strict liability rule.

However, factor (c) talks about a consideration of the inappropriateness of the activity to its location. The thesis in this sub section illustrated to the reader that the word inappropriate cannot be confined to whether the activity was carried on in a proper location. Rather it argued that an activity could become inappropriate by reason of the choice of technique. This argument was based on the simple reason that the slick water hydraulic fracking was chosen amid other alternatives which were far more environmentally friendly due to its cost effectiveness.

Factor (d) bother on question of whether the risk from shale gas can be eliminated by reasonable care. The thesis stated that reasonable care cannot eliminate risks associated with shale gas extraction. Being that the magnitude and the frequency level is beyond the social optimal. Then the thesis looked at factor (e) which is the extent to which the activity is not a matter of common usage. It made a simple argument that shale gas extraction as it were presently is only being used in the U.S and no active extraction is on-going in other countries. That based on this, it cannot be said that the technique of gas extraction passes the common usage test based on the intent of the Restatement (Second) of Tort. The last factor-extent to which the activity's value to the community outweighs its dangerous attributes. The thesis illustrated to the reader that the job opportunities which shale gas extraction activities presents is always short lived and is usually tied to the life span of producing reservoirs. Second, the so-called jobs are based on your field of study or your choice to work in the industry. Whereas, the negative impacts of fracking affect every person within shale sites. *(For detail discussion, see section 5.8).*

To justify a strict liability system for mitigating water contamination risks associated with shale gas development, Chapter V critically explores various statutory, regulatory and the social policy concerns for allowing HVHF. This Chapter also explores inherent difficulties in some theories of law designed to determine defendant's liability regarding shale gas fracking risks, for example, 'Nuisance' and the complexities involved in proofing intent in relation to fracking cases, and the principle of 'Negligence' were explored for the reason being that defining due care and determining whether exercising such care will prevent harm, makes it problematic for a plaintiff in shale claims. This will provide the reader with a broader understanding as to why a strict liability system alongside regulation would achieve the incentive for operators of such a dangerous activity to observe the utmost standard of care.

The thesis examined these principles and the difficulties involved so that it can justify the bases for introducing strict liability for water contamination claims that completely discards the requirements in nuisance, trespass or negligence. The viability of strict liability to fracking claims was discussed as well by making four key assertions based on the factors stated in the *Restatement (Second) of Tort Act.*[71] That water contamination harm attributable to HVHF is significant both in magnitude and in likelihood. That the exercise of reasonable care cannot eliminate HVHF water contamination risk. That the slick water fracking technique fails the common usage test and probably be inappropriate to the location where it is carried on. That it is false that fracking benefits outweighs the environmental and public health risks.

Having laid the foundation in Chapter IV and discussed other key arguments and contributions in Chapter V. Accordingly, Chapter VI will analyse each of the problems

[71]Ibid.

identified in sub section 5.6 that affects the effectiveness of regulation and liability systems against shale gas risks. Such issues include information asymmetry, inability to pay/judgment proof defendant, threat to suit and the cost implications. While information asymmetry is to traditional regulation, inability to pay and threat to suit is to liability system. Cost affects traditional regulation as well as liability. Chapter VII attempts to go further in systemically suggesting key effective strategies from a policy and energy law perspective to address each of the issues identified above. For instance, compulsory disclosure requirements, shifting the burden of proof policy option and the appointment of an independent well assessor were certain solution identified to address the information asymmetry. Strategies such as insurance and bonding were some financial options deployed to address the inability to pay problem. The Polluter Does Not Pay Model adopted in the Indian legal jurisprudence was introduced in addition to the financial requirement solution. This Chapter highlights the novel contributions that this thesis seeks to achieve in the field of mitigating risks associated with most human resource extraction activity that presents a highly probable level of harm occurring. Accordingly, Chapter VIII concludes the arguments and the findings of this thesis.

Chapter 2

2. A Literature Review of the Contributions on Regulatory Reforms for Risk Mitigation

Before the thesis attempts to examine the negative environmental and health impacts of fracking, it is important to do a review of the various literatures regarding energy extraction activities and the proposals made for their safe extraction by scholars in the field. This is important to strengthen the justification for the thesis. Also, to give the reader an insight on key area for further research. However, a brief discussion and definition of what risk is will be important prior to the detailed discussion on the literatures on the contributions on regulatory quality reform in the energy law context. It is better to note upfront a fundamental misconception on the definition of risk. The first myth on the concept of risk is that "risk" must have a single, well defined meaning.[72]

What then is risk?

Given the lack of consensus on the definition of risk. The earliest discussion on risk centred on the distinction between risk that should be quantified objectively and subjective risk.[73] Frank Knight the famous scholar who has been quoted regarding the definition of risk summarized the difference between risk and uncertainty thus:

> *"Uncertainty must be taken in a sense radically distinct from the familiar notion of Risk, from which it has never been properly separated…The essential fact is that "risk means in some cases a quantified susceptible of measurement, while at other times it is something distinctly not of character and there are far-reaching and crucial differences in the bearings of the phenomena depending on which of the two is really present and operating…It will appear that a measurable uncertainty, or "risk" proper, as we shall use the term, is so far different from an un-measurable one that it is not in effect an uncertainty at all."*[74]

Arguably, Knight defined only quantifiable uncertainty to be risk and provided the example of two individuals drawing from an urn and red and black balls; the first individual is ignorant of the number of each colour whereas the second individual is aware that there are three red balls for each black ball. The second individual estimates (correctly) the probability of drawing a red ball to be 75% but the first operates under the misperception that there is a 50% chance of drawing a red ball. Knight's argument is that the second individual is exposed to risk but the first suffers from ignorance. Thus, the emphasis on whether uncertainty is subjective seems to us misplaced. The controversy currently is whether uncertainty is measurable or not even when it is true that risk that is measurable is easier to insure.

Holton in his paper on Defining Risk (2004) argues vehemently that there are two ingredients that are needed for risk to exist.[75] The first is uncertainty about the possible outcomes from an experiment and the other is that the outcomes have to matter in terms of providing utility. He posits that for example, that an individual jumping out of an airplane without a parachute faces no risk since he is certain, that to die (no uncertainty) and that drawing balls out of an

[72]Smith, K. (1996). Environmental Hazards: Assessing Risk and Reducing Disaster, 2nd ed. Routledge, London/U.S.A./Canada

[73]Blong, R. (1996). "Volcanic Hazards Risk Assessment", pp.675-698 I*n:* R. Scarpa and R.I. Tilling (eds.), 1996, Monitoring and Mitigation of Volcano Hazards, Springer-Verlag Berlin Heidelberg New York.

[74]Knight, F.H. (1921), Risk, Uncertainty and Profit, New York Hart, Schaffner and Marx

[75]Holton, G. A. (2004) Defining Risk, *Financial Analyst Journal,* Volume 60. (6) [Online] at https://www.glynholton.com/wp-content/uploads/papers/risk.pdf (Accessed on 24/11/2018) pp.19-25

urn does not expose one to risk since one's well-being or wealth is unaffected by whether a red or black ball is drawn. However, he argues that the drawing of a red or black ball out of an urn will become a risk where different monetary values is attached to red or black balls.

From the above, it is expedient to now give a working, though flawed definition of what risk is. First, risk can be defined as an unwanted event which may or may not occur. Second, risk is the cause of an unwanted event which may or may not occur. Third, risk is the probability of an unwanted event which may or may not occur. Fourth, risk is the statistical expectation values of unwanted event which may or may not occur.[76] Having given a general description of what risk is, it is important to now discuss the various literatures that centres on the regulatory quality improvements within the energy industry.

2.1 Introduction

One thing is clear, when activities that are socially beneficial has the perceived potential of creating harm, the fastest growing and oldest tools for government to mitigate these risks, include: regulations; tort liability standards; and market based instruments. Thus, these three tools deployed by government to tackle these externalities is not an end in themselves, considering the pace of technological advancement. More so, as some scholars have noted, there is, overall, a dearth of data in environmental regulation, and this makes the regulatory task both more difficult and necessary.[77] However, the available literatures vary in terms of the proposal for the approaches most suitable in mitigating shale gas extraction risks.

The need to evolve environmental regulation beyond the normal direct C&C regulatory strategies is increasingly becoming important. To this end, many institutions and researchers have suggested changes and alternatives to the prescriptive form of regulation. Although it is outside the scope of this present research to carry out a broad review of all these initiatives, it is the objective of this thesis to distil and build on the common proposals from the most relevant suggestions specifically on regulatory reforms.

Gouldson, *et al.,*[78] carried out an interesting screening of some initiatives which centred on the Organization for Economic Cooperation and Development (OECD), EU and UK programmes on environmental regulatory reforms. This research was actualised and complemented by some previous literature from the 1990s which played a chief role in promoting the adoption of economic instruments. In addition, other proposals were made by other researches. This thesis shall identify each of these initiatives into three broad segments (institutional, academic and shale gas specific based regulatory reforms) to facilitate a better understanding of the evolving environmental regulatory reforms. These initiatives were targeted toward evolving environmental regulation beyond C&C strategies.

The basis that informed the choice of these three literature sets is that they all support the idea of a complementary regulatory strategy for improving compliance through the deployment of combination of regulatory instruments mixes or regulatory pluralism. Equally these literatures examined in this thesis posits that for regulation to be effective, regulators should leverage on the good will of regulated enterprises first by persuading them to comply with the standards

[76]Helm, P. (1996). "Integrated Risk Management for Natural and Technological Disasters". Tephra, Vol. 15, no. 1, June 1996, pp.4-13.
[77]Wendy, W. (2015). Using competition-based regulation to bridge the toxics data gap, 83 IND. L.J. 629, 629-634. This often forces regulators to guess about effects.
[78]Gouldson, A. *et al.,* (2009). Better environmental regulation-contributions from risk-based decision-making. Science Total Environmental 407 (19) 5283-5288 [Online] http://www.dx.doi.org/10.1016/j.scitotenv.2009.06.13 [Accessed 22 August 2018].

for safety in resource extraction in the energy industry, that when such fails, regulators should progress up the pyramid of regulatory strategies by using their most drastic regulatory strategy to achieve compliance and policy outcomes.

One of the major contributions to the understanding on how pluralistic or instrument mixes regulatory strategies can be most efficient in achieving compliance is that these literatures as well as this thesis agrees that the pyramid of regulatory strategies should not be exclusive of government regulation, but that the pyramid should utilize both second parties (i.e regulated enterprises themselves) and third parties (commercial and non-commercial including civil society) regulations. Regulatory strategies from these collection of sources can together constitute a pyramid of escalating regulatory strategies and sanctions without government hijacking the role of regulatory formulation completely.

Accordingly, these sets of literature's contributions to the understanding on how regulatory strategies can be most effective at accomplishing compliance in risk mitigation in the energy law and policy making is that they set out the principles for how diverse regulatory policy instruments can most effectively be used together to support each other's strengths and weaknesses, and avoid conflicts. These literatures proposed the following combination of regulatory instrument mixes:

Inherently complementary combinations comprising of:

- Information and all other instruments
- Voluntarism and C&C regulation
- C&C regulation and broad-based economic incentives
- Liability rules and C&C.
- Broad-based economic instruments and compulsory reporting and monitoring provisions.

Inherently counter-productive combinations:

- C&C regulation and broad-based economic instruments (which target the same aspects of a common problem).
- Self-regulation and broad-based economic incentives.
- Technology and performance based standards.
- Incentive based instruments and liability rules.

Instrument combinations that should chronologically follow one another:

- Self-regulation and sequential C&C.
- Self-regulation and sequential broad-based economic incentives.

From the above combination of regulatory instruments, it is clear that a central theme that much of the current research on regulatory effectiveness is that, to understand and improve compliance levels within energy law and policy in relation to risk mitigation, it expedient that academics and scholars in the field, must understand how government regulation interacts with other forms "regulation" such as self-regulation, internal corporate management and with the actions of other parties such as civil groups, professional bodies and commercial financial

institutions. In particular, this thesis will build on the notion and concepts of "regulatory pluralism" as espoused in the three sets of literatures examined here to demonstrate a shift from the norm where the state is seen as the only source of regulation.

To this end, this thesis's contribution to the understanding on how mixes of regulatory strategies can be most effective at accomplishing compliance is in suggesting that the pyramid should consist of strategies that will segment particular frequently recurring risks and classify them as abnormal due to their probability level of occurence. Also, such highly probable risks from an activity should be subject to a strict liability claim. By so doing, it is the argument of this thesis that the industry will be forced to self-regulate by being innovative in finding solutions to the recurring risks instead of relying on prescriptive regulations that has failed to solve the recurrence of such highly probable risks (water contamination and earthquakes disturbances from shale gas fracking).

2.2 Institutional Based Regulatory Reforms

The United States Environmental Protection Agency (USEPA) was one of the first, and perhaps the most cited documents establishing environmental principles.[79] This document, written in 1992 but updated in 2009, evaluated key areas of a compliance-based programme designed to primarily focus on enforcement. This could serve as a starting point for inspiration for general environmental regulatory measures.

Without prejudice to other suggestions made by the USEPA, it fundamentally recommended that all environmental regulatory programme should: ensure enforceable requirements; make clear distinction as to who is liable to requirements and to set programme priorities; make compliance (and monitoring) as the focus for regulation; evaluate the success of the initiative; and ensure that programme personnel are to be held accountable for its success or failure.[80]

2.2.1 Economic Instruments to Complement Direct Regulation

The effectiveness of environmental regulation was conducted by some institutions immediately when the first generation of environmental regulation appeared to be successful. The 1990s is the time period where most references to this discussion emanated, signalling the emergence of a strong stance on alternative economic instruments such as taxes, emission markets and others. A vital reference to these alternative economic instruments which has been frequently quoted is a study conducted by the US Congress in 1995.[81] The study sought to subsidise the adoption of alternative policy instruments and assessed how various tools could be harnessed collectively in environmental regulatory strategies to achieve better outcomes. Though the study focused on command and control type of regulation, asserting that coercive enforcement is the fundamental source of achieving compliance from operators of dangerous activities, it developed seven useful parameters to compare instruments regulatory quality, comprised of: assurance in meeting goals; preventing pollution; environmental equity and justice; cost-effectiveness and fairness; demands on governments; adaptability; and technology innovation and diffusion. Subsequently, two other aspects as part of the compliance-based programme were mentioned: extend use of the market to regulate; and improve information collection and disclosure. Command and control form of regulation is otherwise known as (direct form of regulation) where the regulatory body gives the

[79]United States Environmental Protection Agency, (1992). Principles of Environmental Enforcement.
[80]Ibid at p.21.
[81]US Congress- United States Congress, (1995). Environmental Policy Tools: A User's Guide. OTA-ENV-634.US. Government Printing Office, Washington. http://www.princetone.edu/~ota/disk1/1995/9517/9517.pdf [Accessed on 23/03/2018].

regulated certain requirements and obligations to be fulfilled prior to the commencement and during the pendency of the activity. Failure to adhere, could lead to warning with an option of fine or suspension. Where the violation is grave like flagrant abuse of regulatory procedure or gross negligent, criminal prosecution and conviction.[82]

As a result, the adoption of market-based instruments to complement traditional regulation became a subject to be investigated. Diverse grades of success were recorded as countries, agencies and research dedicated huge effort in experimenting and evaluating the options from taxes to emission markets as illustrated by UNEP.[83] Thus, according to authors like Baumol and Oates[84] who believed the general hypothesis that environmental problems emanated from market failures, solving them required giving markets the right signals through the establishment of economic rewards associated to environmental policy objectives which would impact the behaviour of firms.[85]

The International Monetary Fund (IMF) also gave voice for the adoption of these economic instruments and criticised traditional regulation. It argued that traditional regulations are: economically inefficient; full of administrative burdens; barriers to innovation; and create the possibility for regulatory capture. [86] The authors of this IMF document concluded that no one model was enough to solve every challenge, proposing that market solutions are always ideal, and suggesting that practicability, efficiency, equity, ecological incidence, information requirements and availability, transition problems and administrative costs should be the considerations of a new environmental regulation.[87] Further, the IMF suggested that finding a way to determine the acceptable limits of risks by society in standards, as well as ensure the capacity to monitor and inspect compliance, should be the priority of regulatory reform. According to the IMF, this would reinforce the need for government's commitment, represented by the establishment of strong environmental agencies, supported by the required resources.

The idea of using a market-based approach as an alternative to regulation as part of a regulatory reform agenda received recommendation too from the Economic Commission for Latin American and Caribbean (CEPAL). However, Bettts[88] proposed an increased use in the preventive approach: search for cost effectiveness through economic instrument adoption; and the use of revenues from environmental taxes to finance environmental agencies once it is evident that financial limitations has hindered success as an approach to new environmental regulation.

The World Bank (WB) recommended the use of the market based approach as a new environmental regulatory reform for developing countries.[89] The conclusion of the WB was

[82]Openstax CNX. (2018). Command and control Regulation, *Creative Commons,* Rice University, [Online] https://cnx.org/contents/4qkw4ZtV@3/Command-and-Control-Regulation (Accessed 18/9/2018).
[83]United Nations Program, (2004). The Use of Economic Instruments in Environmental Policy: Opportunities and Challenges. UNEP, Paris [Online] htpp://www.unep.org/pdf/PRESME_hnadbook_2010.pdf (Accessed 23/08/2018).
[84]Baumol, J.C & Oates W.E, (1989). The Theory of environmental Policy, Cambridge University Press, Cambridge.
[85]Hahn, R.W. (1989). A Primer on Environmental Policy Design. Fundamentals of Pure and Applied Economy. Harwood, Washington.
[86]Ibid.
[87]Ibid p.12.
[88]Betts, M. (1991). Economic Policy Measures for the Improvement and Protection of the Environment. Regional Seminar on Policies for the Management of Urban and Industrial Management. CEPAL, Santiago.
[89]World Bank, (2000). Greening Industry-New Roles for Communities. Markets and Governments. Oxford University Press, Washington. [Online]

that a new regulatory logic is required, mainly due to the recognition that regulated efforts in improving performance and taking profit from economic rationale through market-based instruments. It proposed a reform approach that welcome new approaches, including: taxes and information requirements; creates participation; information intensive processes; and transparency. In short, this was an approach that ensured that the environmental institutions work more as mediators and less as dictators of rules, arriving at strategic decision on a cost-benefit analysis of regulatory actions and rules and making use of informal regulation, as information-based instruments, and technical assistance.[90]

Whereas some researchers argued that the expectation on economic instruments should be treated with care, mainly in developing countries,[91] the Inter-American Development Bank (BID) argued in their publication[92] that the hypotheses for the economic rational could not be verified in real situations as anticipated. Thus, proposing a much more cautious understanding of environmental regulatory dynamics, they stated that the issues of high transaction costs of economic instruments, the inadequacy of economic instruments and the limited institutional architecture in developing countries are the most relevant problems that can affect the use of economic instruments in a new environmental regulatory reform. This publication suggested that the analyses should transcend economic aspects and evaluate the following: aspects of stakeholder institutional capabilities; level of governmental commitment; data availability on pollution sources and environmental quality; legal and administrative contexts for environmental regulation; and resource availability within environmental agencies.[93]

2.2.2 Regulatory Quality Efforts of the OECD

At the end of the 1990s, the OECD tried to review regulatory quality, which primarily meant achieving a reduction in bureaucratic and administrative costs and burdens involved in enforcing legal compliance.[94] As part of the Organization's first attempt to review regulatory quality, it highlighted eight principles which it argued should form the establishment of a good regulation. It recommended that regulation should clearly: identify policy goals, and be effective in achieving same; have a legal and empirical basis; have the ability to reflect benefits that justify costs; reduce costs and market distortions, encourage innovations through market incentives and goal-based approaches; be clear, simple, and practical; avoid inconsistency with other regulations and policies; and should not be incompatible as far as possible with competition, trade and investment facilitating principles.[95]

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http;//www.worldbank.org/external/default/WDSContentsServer/W3P/P/IB/2000/12/13/000094946_9911245059/Rendered/PDF/multi_page.pdf. Accessed on 24/08/2018).

[90]Ibid.

[91]Russel, C; & Powell P. T. (1997). La seleccion de instrumentos de politica ambiental. Problemas teoricos y consideracions practicas. ID, Washington, http://www.iadb.org/pt/tpublicaticancoes/detalhes7101.html?id+18866 (Accessed on 24/07/2018).

[92]Ibid.

[93]Ibid.

[94]Organization for Economic Co-operation and Development [OECD]. (2008). Measuring regulatory quality. *Policy Brief* OECD Observe. OECD, Paris. [Online] http://www.oecd.org/redirect/regreform/regulatory-policy/40395187.pdf (Accessed on 24/08/2018).

[95]Organization for Economic Co-operation and Development. (1995). Recommendations of the Council of the OECD on Improving the Quality of Government Regulation. OECD, Paris. http://www.acts.oecd.org/instruments/ShowInstrumentView.Aspx?InstrumentID+128&InstrumentPID+124Lang+en&Book+False. (Accessed 24/08/2018).

These principles were substituted by the *guiding principles for regulatory quality and performance*[96] which provided guidelines such as: the need to conduct regulatory reform at a broad political level; establish clear objectives and frameworks; assess impacts and review regulations systematically; ensure non-discriminatory issues and transparency; review and strengthen scope, efficacy and enforcement of competition policy; economic regulations that should encourage competition and efficiency; remove unnecessary regulatory restrictions; and highlight vital linkages with other policy goals.

Subsequent to the above guidelines, three surveys were conducted to evaluate the quality of regulatory systems in OECD countries in 1998, 2000 and 2005, respectively. The results of these surveys made a set of recommendations which proposed that regulations should be: proportionate to the identified problem and goals, with a minimal burden for compliance; prompt in addressing identified problems; effective in achieving objectives with minimum cost; avoid inconsistency with other existing regulations; flexible and not too prescriptive; be open to improvement by continuous update; be accommodating and an effective means of communication with stakeholders; be open and able to be held accountable; reflect respect for legal and constitutional requirements; and be enforceable.[97]

2.2.3 Better Regulation

The EC carried out a review on regulatory quality similar to the OECD studies on governance reforms known as 'better regulation'.[98] An aspect of the EC study focused on the establishment of five principles for good governance: openness; participation; accountability; effectiveness; and coherence.[99] Consequently, these criteria have been evaluated and applied to over 400 policy initiatives.[100] The 6th Community Environmental Programme was then established following the rapid traction that 'better regulation' had within environmental regulation, providing guidelines for thematic strategies for 2002-2012.[101] For the thematic strategies to assume the status of those better regulation efforts, it must be predicated on impact assessments with particular reference to stakeholder consultation, simplification and cross-cutting issues and linkages.[102] The *Reporting on Environmental Measures (REM)* project suggested a methodology to report and evaluate impacts of regulation on the local

[96]Organization for Economic Co-operation and Development, (2005). OECD Guiding Principles for Regulatory Quality and Performance [Online] http://www.oecd.org/redirect/regreform/regulatory-policy/34976533.pdf (Accessed on 24/08/2018).

[97]Jacobzone, S; & Choi, C. (2007). Indicators of regulatory Management Systems. OECD Working Papers on Public Governance, n.4 OECD Publishing, Paris. [Online] http://www.oecd.org./gov/regulatory-policy/44294427.pdf (Accessed 24/08/2018).

[98]Commission of the European Communities, (2001). European Governance e a White Paper. COM (2001)428. Commission of the European Communities, Brussels [Online] http://wwweur-lex.europa.eu/LexUriServ/LexUriServ.do?uri¼COM:2009:0015:FIN:en:PD(Accessed 23/02/2017).

[99]Commission of the European Communities, COM. (2009). European Governance e a White Paper. COM (2001)428. Commission of the European Communities, Brussels [Online] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri¼COM:2009:0015:FIN:en:PD (Accessed 23/02/2017).

[100]Ibid.

[101]European Environment Agency, EEA s/d. Paper1: (2002). Defining criteria for evaluating the effectiveness of EU environmental measures. EEA, Copenhagen. [Online] http://www.eea.europa.eu/publications/rem/defining.pdf/view. (Accessed 23/02/2017).

[102]Commission of the European Communities, COM. (2005). Better Regulation and the Thematic Strategies for the Environment. Commission Working Document SEC, 1197. Commission of the European Communities, Brussels [Online] http://www.eurlex.europa.eu/LexUriServ/LexUriServ.do?uri¼COM:2005:0466:FIN: EN:PD

environment.[103] Further, the European Agency reported[104] on some specific policies, whilst some studies carried out by member states such as the UK task force provided some parallel initiatives that were conducted in addition to the 'better regulation' initiative.[105]

The final report of the 6th European Action Programme (EAP) listed many positive outcomes from the initiatives. Nevertheless, it listed and recognised that expected regulatory reform goals had not fully become a reality because of planning and implementation burdens. Thus, the EAP made recommendations for new future objectives whereby member states should focus on pollution prevention and resource efficiency, integration of environment into business models and other policies, ensure a robust base of indicators to inspect and evaluate impacts of policies, carry out better evaluation of regulatory action to see if it has the ability to change consumers behaviour, and incorporate environmental policy planning with financing schemes among other initiatives.[106]

2.2.4 Other Institutional Proposals for Regulatory Reforms

The UK Sustainable Development Commission (SDC) report was among those huge efforts that contributed towards principle setting for regulatory reforms.[107] A governmental independent body, the SDC determined five principles of good regulation: being proportionate; accountable; consistent; and transparent and target oriented. It made recommendations for the elimination of obsolete and inefficient regulation, the establishment of guidelines to facilitate compliance, the need to identify and address inconsistencies and reduce bureaucracy and compliance costs.

To this end, the UN and the International Development Research Centre (IDRC), a Canadian Institution jointly compiled a study regarding the relationship between market, regulation, commerce and innovation.[108] Acknowledging the huge potential for good regulation to influence and improve competitiveness and environmental protection, the document favoured a regulatory reform based on reflexive learning, pushing enterprises to understand the benefits embedded in securing the social license to operate. Proposals within the documents encouraged: a push for the environmental agenda to be included in economic policies; adopt a collaborative relationship with enterprises; equip regulators with the requisite training and resources; a deliberate focus on prevention as a priority; foster innovation and encourage technical assistance in problem solving and the expansion of enforcement particularly in developing countries;[109] promote research and development and share new solutions among

[103]Newcomb, J. (2000). Reporting on the effects and effectiveness of measures taken to implement UE Environmental Legislation: Case Study-the Waste Directives. EEA, Copenhagen [Online] http://www.eea.europa.eu/publications/rem/waste.pdf (Accessed on 4/02/2017).

[104]See supra Commission of the European Communities, COM. (2005) footnote 102.

[105]See supra Newcomb, J. (2000) footnote 103.

[106]Commission of the European Communities, COM. (2011). The Sixth Community Environmental action programme e Final Assessment. COM (2011)531. European Commission, Brussels [Online] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do? uri¼COM:2011:0531:FIN: EN:PD.

[107]Coote, A. *et al.,* (2009). Better Regulation for Sustainable Development. Sustainable Development Commission Reports & Papers, London. [Online] http://www.sd-commission.org.uk/data/files/publications/Better_regulation_for_sustainable_development.pdf (Accessed on 3/01/2018).

[108]Chudnovsky, D; & López, A. (2007). Environmental management and innovative capabilities in argentine industry. In: Parto S & Herbert-C. B. (ed.). Industrial Innovation and Environmental Regulation. United Nations Press, New York, pp. 81e114. http://www.idrc.ca/EN/Resources/Publications/Pages/IDRCBookDetails.aspx?PublicationID¼141 .

[109]Gunningham, N. (2007). Reconfiguring environmental regulation: next-generation policy instruments. In: Parto, S., Herbert-Copley, B. (Eds.), Industrial Innovation and Environmental Regulation. United Nations Press,

member states; incentivise the voluntary efforts of companies; refrain from using regulation as a barrier to trade; create a conducive environment for civil society groups to participate in decision making process; create avenues to facilitate access to the development of new technologies through the grant and loan facilities;[110] extend where necessary the use of self-regulation; expand the use of non-traditional strategies for protection (shaming, and informal sanctions, etc.); deploy the use of economic constraints in which firms operate.[111]

The civil society groups were not left out in the major contributions. The Progressive Policy Institute (PPI) proposed that a reform anchored on 'progressive governance' principles, comprised of: making environmental objectives as a priority;[112] setting realistic goals; focusing on environmental outcomes instead of technologies; periodic review laws and procedures; decentralised decisions;[113] increased regulatory flexibility, going beyond prescriptive safety guidelines; rewarding companies for their performance; involving actors including communities; creating a consistent approach to sectors and regions; restructuring regulatory assignments; making funds available to agencies; concentrating on more environmentally friendly production; rendering technical assistance where necessary; and the disclosure of information for better regulatory efficiency.[114]

2.3 Academic Contributions of Regulatory Reform Improvements

In addition to institutional studies dedicated to regulatory reform, some academic researchers have also contributed by proposing innovative ways to regulate. In this light, some contributions are briefly discussed, but the aim is to illustrate a number of relevant contributions to environmental regulatory quality principles consolidation.

2.3.1 Regulation, Self-Regulation and Risk

Regulation entails the formulation of diverse set of rules through legal instruments by which governmet set requirements on enterprises and citizens.[115] These sets of requirements are not limited to laws and formal orders, but transcends to administrative instruments used to pursue policy objectives and goals. Also, one analyst has written:

> *Regulation refers to sustained and focused control exercised by a public agency over activities that are socially valued. The reference to sustained and focused control by an*

New York, pp. 200e 232. http://www.idrc.ca/EN/Resources/Publications/Pages/IDRCBookDetails.aspx?PublicationID¼141.

[110]Parto, S. (2007). Introduction. In: Parto, S., Herbert-Copley, B. (eds.), Industrial Innovation and Environmental Regulation. United Nations Press, New York, pp. 1e21. http://www.idrc.ca/EN/Resources/Publications/Pages/IDRCBookDetails.aspx? PublicationID¼141.

[111]Barton, J. R. (2007). Environmental regulation and industrial competitiveness in pollution-intensive industries. In: Parto, S. Herbert-Copley, B. (Eds.), Industrial Innovation and Environmental Regulation. United Nations Press, New York, pp. 51e80; Yap, N., Devlin, J., Wu, C.C., Ton, S., 2007. Corporate environmental innovation and public policy: case studies from Taiwan. In: Parto, S., Herbert-Copley, B. (Eds.), Industrial Innovation and Environmental Regulation. United Nations Press, New York, pp. 22e50. http://www.idrc.ca/EN/Resources/Publications/Pages/ IDRCBookDetails.aspx?PublicationID¼141.

[112]Knopman, D; & Fleschner E. (1999). Second Generation of Environmental Stewardship. PPI Policy Report, Mai. 1999. http://www.dlc.org/print0cf5.html? contentid¼767.

[113]Swift, B. (2000). How Environmental Laws can Discourage Pollution Prevention. PPI Policy Report, 01 ago. [Online] http://www.dlc.org/ndol_ci831c.html? kaid¼116&subid¼150&contentid¼1159 (Accessed 5/11/2017).

[114]Knopman, D. (2000). Licence to Innovate e an Agenda to Modernize the Tools of Environmental Protection. Blueprint Magazine. Fev. http://www.dlc.org/ndol_ ci8160.html?kaid¼116&subid¼150&contentid¼2979.

[115]Jacobzone, S. *et al.,* (2007). Indicators of Regulatory Management Systems. OECD Working Papers on Public Governance, n.4 OECD Publishing Paris [Online] http:www.oecd.org/org/gov/regulatory-policy/44294427.pdf (Accessed on 21/11/2018) p.101.

> *agency suggests that regulation is not achieved simply by passing a law, but requires detailed knowledge of, and initimate involvement with, the regulated activity.*[116]

The inevitability of risks from human activities that present negative effects on certain aspects of the environment such as air, soil, water and ecosystems calls for the need for regulatory reforms. To this end, environmental protection requirements have garnered huge attention among the agenda in modern governance issues in countries across the world. Thus, making countries to develop strategies, legislation and administrative orders, and establish designated institutions to prevent, reduce, control or remediate the negative impacts of human interaction on the environment and human health generally recognised as "environmental regulation"[117] To reform regulation means to improve the efficiency, flexibility, simplicity, and effectiveness of individual regulations and non-regulatory instruments.

However, these environmental regulation generally known as the C&C form of regulation is fashioned based on normative prescriptions for environmental requirements exemplified through emission standards contained in licenses issued by environmental agencies. These licenses set specific standard requirement based on legal determinations. C&C regulation expects that licensed activities must comply with those requirements by reducing risks to the regulatory standards or threshold.[118] Interestingly, C&C still forms a core strategy for the majority of environmental agencies worldwide in addressing risks from human activities. However, a recent review of the strategies of the prescriptive regulatory approach has begun to show its limitations in dealing with contemporary environmental complex challenges. Such contemporary environmental problems range from diffuse and persistent kinds of contamination or pollution risks to dispersed risks of harm associated with human extractive activities. This immediately resonates new policy concerns of the economic efficiency of regulation.[119]

Despite the central importance of C&C strategies of environmental regulation, both regulators and regulated entities recognize that these prescriptive strategies are not enough to deal with present environmental challenges. As a complement to the traditional approaches, it is imperative the tenets of self-regulation as an alternative form of regulation should be explored and strict environmental liability tools should be incorporated to address the limits on regulatory economic efficiency which the traditional C&C exemplifies.

Therefore, this thesis argue that the major debate surrounding regulation and self-regulation is the inability of C&C regulation to address more diffuse and persistent forms of risks associated with human activity. Self-regulation on the other hand does not dwell on risk abatement, it goes further to risk prevention because the regulated entities assume a rational behaviour when they see that they are given some level of discretion to mitigate risks from their activity rather than adhering to standards set by the regulatory agencies.

In view of this paradigm, this work relied on literatures that promote a strict environmental and pluralistic environmental regulatory improvement strategies. The pluralistic regulatory reform improvements proposed in the literatures is adopted in this thesis because these

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[116]Arlen, J. & Kraakman, R. (1997), "Controlling corporate misconduct: An analysis of corporate liability regime" 72(4) *New York University Law Review,* pp.687-779.

[117]Ibid.

[118]Gray, W. B; & Shimshack, P. (2011). The effectiveness of environmental monitoring and enforcement: a review of the empirical evidence. Rev. Environ. Econo. Policy 5(1), 3-24 [Online] www.http://dx.org/10.1093/reep/re017 (Accessed 21/11/208).

[119]Rejeski, D. (2004). How new environmental technologies can stimulate economic growth. Progressive Policy Institute, Washington.

strategies in order to achieve effectiveness of regulation, does not limit itself to attaining the legal standards of C&C. Rather is pushes operators to prevent risks and not treat the harm that may occur from accidents. Thus, regulations is not seen as an end-of-pipe solution but a means to enforce rational behaviour.

Of greater importance is that the pluralistic regulatory quality reform for improving effectiveness and efficiency of any form of regulation is centred on achieving compliance and achieving policy goals as well. Though compliance is not always possible because legitimate enterprise are always careful in following all set rules so they go out of business simply because they strived toward full compliance of regulatory rules. Whereas, other literatures who propose for example corporate social responsibility or risks governance as a means of improving regulation in mitigating risks, depend solely on compliance to the set standards but is less concerned on achieving the policy objective. Regulated enterprise's compliance to regulatory rules is dependent on certain conditions.

The first condition is that the target group has to be aware of the rule and understand it. This is true because lack of clarity in a rule may result in unintentional non-compliance. Second, there must be willingness on the part of the regulated enterprise or industry to comply to set rules. Economic incentives have proven to foster a willingness to comply. In some cases a severe *enforcement* programme is also most likely able to discourage a non-compliant behaviour. The third condition has to do with the ability of the target group to comply. For certain regulatory rules and policy to be implemented, it requires the provision of necessary information and other technical support. Non-compliance becomes almost impossible if any of these conditions is not met. Thus, policymaker's should direct their quality control activities not only to the drafting and publishing of a rule, but must ensure that the three conditions are met to ensure regulatory compliance.[120] These conditions underscores the very need for a pluralistic/multi-dimensional approach of regulatory quality reform within energy law.

2.3.2 Ecological and Environmental Economics

The subject of economic factors regarding the environmental protection debate is not a new issue. Different aspects of economics has been analysed within regulatory architecture since the early days of environmental rules and legislation.[121] Two clear movements can be examined critically.

'Environmental economics' is the first approach which adopted the internalisation of externalities, understanding pollution as the "consequence of an absence of prices for certain scarce environmental resources".[122] The way to address these externalities, they argued, on the one hand, lies in specifying a price and then conducting cost-benefit analysis. Other academic contributors to the debate, on the other hand, proposed a reduction in the transaction cost involved in policy implementation, an issue not new to regulatory design.[123] This paper stated that the main features for environmental regulation listed by environmental economics academics are: the deployment of economic instruments as a first preference; accepting uncertainty as inevitable in decision making; seeking marginal and transaction abatement cost

[120]Ayres, I. & Braithwaite, J. (1996). Responsive Regulation: Transcending the Deregulation Debate, Oxford University Press, New York, p.11.
[121]Pearce, D. (2002). An intellectual history of environmental economics. Annual. Rev. Energy Environ. 27, 57e81. http://dx.doi.org/10.1146/annurev.energy.27.122001.083429.
[122]Croper, M & Oates, W. E. (1992). Environmental economics a survey *Journal of Economic Literature*. 30 (2) p. 675.
[123]McCann, L. (2013). Transaction costs and environmental policy design. Ecol. Econ. 88, 253e262.

reduction; a consideration of existing alternatives including technology and institutional, to mitigate costs; investing in information campaigns; and evaluating the pros and cons.

Recently, a new generation of economists complemented the environmental economy debate to include sustainability as part of the issues to be considered, mainly on the premise that environmental goods and services are scarce and fraught with capacity constraint.[124] These scarcity and capacity problems created the ecological aspect of the equation in regulatory reform improvement.[125] This recent research brought about a focus on the relationship between ecosystems and economic systems, giving high preference to ecological valuation methodologies because all indices show that current regulatory systems have not attached sufficient importance in the management of environmental resources for sustainability.[126]

In common, all these authors have recognised this gap and proposed regulatory reform aspects that can be summarised as follows: a focus on sustainability as a goal; the adoption of a preventive approach; ensuring that ecosystem resilience is maintained, as well as the natural stock; improved instruments for flexibility and efficiency; and the need to adhere to scientific based processes and ensure institutional improvement.[127]

2.3.3 Ecological Modernisation

The 1980s led to the emergence of the ecological modernization theory from a small select group of European researchers. It generally evaluated the interaction of stakeholders during the regulatory process at different scales and made recommendations for improvements from concepts such as 'reflexive modernisation'[128] and risk society.[129] This theory criticises alarmist perspectives toward environmental crises issues. However, the theory sought to strike harmony between ecological rationales for economic growth with environmental preservation.[130] Recognizing that many problems presented some form of opportunity for reform, this suggested the need for environmental criteria and instruments, and that requirements should be adjusted to suit market conditions.[131]

In this regard, the theory formulated five pillars aimed to promote dialogue and negotiations. They include: recognising the potential of science and innovation to proffer solutions; increasing the potential for market dynamics in the requirement of definitions; reviewing regulations to be more flexible, adaptive, decentralised and participatory; modifying the role and position of social movements in decision making; and making environmental and economic needs to be mutually inclusive.[132] In summary, the ecological modernisation

[124]Daly, H. (2008). A Steady-State Economy. Sustainable Development Commission, Londre.
[125]Constanza R D *et al.,* (1991). Goals, agenda and policy recommendations for ecological economics. In: Constanza, R. (ed.), Ecological Economics: the Science and Management of Sustainability. Columbia Univ. Press, New York, pp. 1e20.
[126]Ibid at p.14.
[127]Ibid.
[128]Beck, U. *et al.,* (1994). Reflexive Modernization: Politics, Tradition and Aesthetics in the Modern Social Order. Polity Press, Cambridge.
[129]Beck, U. (1992). Risk Society: Towards a New Modernity. Sage, London.
[130]Berger, G. *et al.,* (2001). Ecological modernization as a basis for environmental policy: current environmental discourse and policy and the implications on environmental supply chain management. Innovation 14 (1), 55e72. http://dx.doi.org/10.1080/13511610125074.
[131]Mol, A P. (2009). Ecological modernization: Three decades of policy, practice and theoretical reflection. In: Mol, A., Spaargaren & P.J., Sonnenfield, G. (Eds.). The Ecological Modernization Reader: Environmental Reform in Theory and Practice. Routledge, London and New York, pp. 3e14.
[132]Mol A. P.J & Sonnenfield, D.A, (2000). Ecological modernization around the world: An introduction. *Environ. Political*. 9 (1), 3e16. http://dx.doi.org/10.1080/ 09644010008414510.

concept called for a pragmatic regulatory reform where negotiations are decentralised, the use of market instruments is expanded, awareness of the recognition of government's inability to tackle all problems alone. Further, it called for the adoption of a more participatory style of decision making, the creation of long term achievable goals for environmental agencies, the substitution of governance for government, a focus on prevention and the aim for self-regulation and voluntary agreements.[133]

2.3.4 The Strict Environmental Regulatory Reforms

First popularised by Porter and Van der Linde,[134] reflective contributions espouse the relationship between environmental regulation and competitiveness. Also, that a well-designed environmental standard can push for innovation that may partially or more than fully eliminate the costs of complying with them. As a result, a lot of research have confirmed this hypothesis reasserting that Porter's hypothesis does not require further complementary strategies.[135] The focal idea behind their contribution otherwise known as the Porter Hypothesis is that strict environmental regulation has the potential of enhancing competitiveness.[136]

A discussion of the Porter Hypothesis is outside the purview of this thesis. Nevertheless, the suggestions made for regulatory reform are quite useful. The most relevant include: focusing on result, not on technology; maintaining restrictive regulation; regulation should extend even to the end user, and encourage the search for solutions from previous stages of production and consumption chains; encourage the use of market incentives; harmonise legislation; ensure there is consistency with other countries legislations or slightly below theirs; maintain a certain level of regulatory process stability and predictability; engage regulated communities in the design process from the beginning; minimise the time and resources consumed in the regulatory process.[137]

2.3.5 Performance Based Regulatory Reforms

Amidst the debate of new regulatory reform improvements, requests arose from industry participants championing the drive in sustainability efforts for new regulatory style. This group requests that their environmental performance efforts should be taken into account whilst setting environmental standards. Hence, the strategy called 'performance based regulation'.[138] This genre of regulation is based on the assumption that 'one-size-fit-all' regulatory approaches are not fair or effective, and that government does have the absolute prerogative to determine the better solutions to all problems. In this regard, they have supported the stance that better performers should be allowed to contribute toward

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[133]See supra Beck, U. *et al.,* (1994) footnote 128

[134]Porter, M & Van der Linde, C. (1995). Toward a new Conception of the environment competitiveness relationship. Journal. Economic. Perspective. 9 (4), 97e118. http://www.jstor.org/discover/10.2307/2138392?uid¼2129&uid¼2&uid¼70&uid¼4&sid¼21102993758061 (Accessed 12/07/2017).

[135]Parto, S. (2007). Introduction. In: Parto, S., Herbert-Copley, B. (eds.), Industrial Innovation and Environmental Regulation. United Nations Press, New York, pp. 1e21. http://www.idrc.ca/EN/Resources/Publications/Pages/IDRCBookDetails.aspx? PublicationID¼141.

[136]Ibid at p.98.

[137]See supra Barton, J. R. (2007) footnote 111

[138]Coglianese, C *et al.,* (2002). Performance and regulation: a conceptual overview. *Regulatory Policy Program Workshop,* Washington; Coglianese, C., (2004). Performance-based regulation: Prospects and limitations in health, safety and environmental regulation. *Centre for the study of law and society bag lunch Speakers series*. Paper 10. University of California, Berkley. [Online] http://www.dx.doi.org/10.2139/ssrn.392400 (Accessed 01/10/2017).

improvements. This performance based regulatory reform is mainly focused on information disclosure, the establishment of indicators and performance evaluation methods.[139]

Despite this regulatory architecture being focused on performance and flexibility, other relevant aspects suggested are: the use of information and technical assistance as instruments; creating more flexible licenses based on performance standards; encourage the use of funds collected as fines to fund improvements in companies; adopt self-regulation tools; ensure continuous improvements; create administrative benefits for those who uphold the highest form of environmental performance improvements; maintain consistent rigorous standards; assist small and medium enterprises technically and financially; set achievable targets within a long term period; use regulation to engender innovation; and mobilise resources for monitoring.[140]

2.3.6 The Pluralistic Regulatory Approach

Other vital contribution regarding the reform for improving regulation as frequently referred to by researchers is known as 'smart regulation' which Neil Gunningham and Darren Sinclair elaborated on in their work.[141] Their main article admitted the insufficiency of command and control regulatory strategy, suggesting a more effective, efficient, equitable and politically acceptable approach. Gunningham and Sinclair argued that achieving a better regulatory design involves a more imaginative, flexible and pluralistic approach in conjunction with those suggestions described above by Gunningham Neil. Therefore, the article proposes five 'regulatory design principles' to serve as guidelines and a roadmap for policy makers which include: incorporating instrument and institutional combinations; the preference of less interventionist measures; the escalation up regulatory measures to the extent necessary to achieve policy objectives; give room for participants who are in the best position to act as surrogate regulators; and maximise opportunities for win-win outcomes.[142]

2.3.7 The 'New Environmental Regulatory' Approach

Daniel Fiorino, former director of USEPA, proposed a regulatory reform to directly discuss how environmental regulation can be harnessed to expand its influence on the behaviour of firms and thus obtain more ambitious environmental outcomes.[143] According to Fiorino, in his defence of regulatory reform, he stated that regulation is more of a learning process issue than a political struggle. The following guideline proposals were formulated by Fiorino: making regulation more comprehensive; preventing regulatory capture by firms or environmental groups; channelling the degree of regulatory pressure in relation to environmental performance; and developing learning from environmental experiences and outcomes.

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[139]Ribeiro, F.M & Kruglianskas, I. (2013). Improving environmental permitting through performance-based regulation: a case study of Sao Paulo State, Brazil. *Journal of Clean Production*, Volume 46, 15e26. [Online] http://www.dx.doi.org/10.1016/j.jclepro.2012.09.017.

[140]Zarker, K. A & Kerr, R. L. (2009). Pollution prevention through performance-based initiatives and regulation in the United States. J. Clean. Prod. 16 (6), 673e685. http://dx.doi.org/10.1016/j.jclepro.2007.02.018.

[141]Gunningham, N & Sinclair, D. (2002). Leaders and laggards: Next generation environmental regulation. Greenleaf Press, Sheffield.

[142]Howlet, M & Rayner, J. (2007). Design principles for policy mixes: cohesion and coherence in 'New governance arrangements'. Policy Soc. 26 (4), 1e18. http:// dx.doi.org/10.1016/S1449-4035(07)70118-2.

[143]Fiorino, D. J. (2006). The New Environmental Regulation. MIT, Massachussetts.

2.4 Shale Gas Specific Regulatory Reforms

Other research has served to provide a review of the economic and environmental implications of shale gas development around the world.[144] Furthermore, the present research provided a comprehensive review of the challenges and implications regarding sustainability and economic aspects associated with the development of shale gas as an energy source at the global, regional, and local scale. Water contamination and use have been the common recurring theme from the reviewed studies in terms of shale gas extraction risks.[145] They all identified a need for sustainable shale gas fracking.

Similarly, another study[146] using Pennsylvania state regulation, proposed ten key principles to reduce the risks and to increase the net rewards of UOGE. These ten principles as suggested by the study would be in addition to existing regulations and include: undertaking greater levels of pre-production measurement and monitoring, especially of ground water levels and quality, so as to establish a clear baseline for subsequent assessment; improve transparency by operators throughout the production process, particularly when fracturing operations are conducted, so that the public can have confidence in the operations and also compliance with regulations; heighten scrutiny on well integrity, so as to give the greatest possible assurance that no cross contamination of water resources will occur over the entire lifetime of the well, including when production ceases and wells are capped; treat or adequately dispose of both formation water and fracturing fluids for shale gas; minimise air emissions, especially of methane, from flaring or worse, venting; employ regional approaches to measure cumulative impacts, given the large numbers of wells drilled; lower operating risks (for example, less toxic fracturing chemicals, greater recycling of produced water) through rigorous and adequately resourced compliance work, funded by industry, and which includes the monitoring of fracturing operations; either establish purpose-built regulatory agencies in jurisdictions where this is appropriate or support better coordination across relevant agencies to respond to the complex issues spanning the range of government responsibilities; mandate on-going reviews of regulatory adequacy and cost/complexity, bolstered by experience and insights from global experience; and provide provision of adequate funding from the industry itself, for monitoring, assessment and compliance across the production process.[147]

As part of the regulatory response required to tackle risks associated with shale gas extraction, some studies[148] have also suggested the establishment of "Superfunds" and the signing up to an insurance scheme as part of the requirements for the grant of permit to explore for and extract shale gas resources. Superfunds are meant to address pollutions**,** which might be urgently required to tackle pollution from oil and gas accidents. Whereas the insurance schemes operate as a check between the financial institution who in this circumstance is a

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[144]Andres J. C. *et al.,* (2018). "Disclosing Water-Energy-Economics Nexus in Shale Gas Development" *Applied Energy* Vol. 225 p.1 [Online] https://www.doi.org/10.1016/j.apenergy.2018.05.001. (Accessed on 23/02/2018).

[145]Mitchell, R. L *et al.,* (2018). 'The impacts on perceived risks from unconventional shale gas development' *Journal of Environmental Management,* Volume 218, pp.630-638; Shiqian Wang., (2018). Shale Gas Exploitation: Status, Problems and Prospect. *Natural Gas Industry B, Volume 5 Issue 1 Pp. 60-74 [Online]* https://www.sciencedirect.com/search/advanced?qs=regulation%20of%20shale%20gas%20and%20unconventional%20source&show=50&sortby=relevance [Accessed on 12/08/2018).

[146]Ian, C R & Quentin, G et al., (2016). Economic benefits, external costs and the regulation of unconventional gas in the United States. *Energy Policy,* Volume 98 pp.180-186 [Online] https://www.sciencedirect.com/search/advanced?qs=regulation%20of%20shale%20gas%20and%20unconventional%20source&show=50&sortby=relevance [Accessed 12/08/2018).

[147]Ibid at p.185.

[148]Carol, M. L & Inder, K. K. (1997). Superfund liabilities and governmental reporting entities: An empirical analysis. *Journal of Accounting and Public Policy,* Volume 16 Issue 2 pp.155-186.

quasi-regulator of the oil and gas companies. This seems helpful because companies have the greatest inkling and incentive to adhere to the prescribed best practices for fear of being declined when applying for financial loans or standing the chance of receiving an increased premium claim made against the operator.[149]

A paper[150] carried out a comparative analysis of the two environmental law principles that should guide the regulation of shale gas extraction in EU. According to the work, the two principles are the main tools of European law, which aim to strike a balance between enabling and prohibiting the development of an emerging energy technology like shale gas extraction. Nevertheless, all these proposed guidelines for environmental regulatory reform admit the fact that regulation is the key strategy that can guide the extraction of shale gas from any region.

Notwithstanding the similarity in these articles in that they are all targeted towards promoting regulatory effectiveness in mitigating risks associated with shale gas extraction, they have also made a common recommendation for more inclusive research to be conducted into the existing regulatory approaches with divergence. As a result, this thesis observed that all regulatory responses have not been able to adequately argue how liability systems can be included into regulation in mitigating shale gas risks. Particularly, the issue of operators being shielded from liability having complied with all available regulatory guideline and standards in ensuring environmental and health protection.

This and other issues that will be identified during this research in detail underscores the fundamental problem of why regulations and liability systems might remain ineffective. Whilst most studies and scholars have measured the effectiveness of regulation based on the compliance level to all available safeguard standards, this thesis begs to deviate from such narrow representation and, in doing so, argues that effectiveness of regulation and liability systems should transcend to the realm where operators will still be liable even though they have complied with the prescriptive safeguard standards for mitigating risks during their operations.

The issue of regulatory capture either by oil and gas companies or environment groups is another reason why even a well-crafted regulatory framework might lose its potency. This capture may arise because companies or environmental groups may contribute to the formulation of some safety regulatory responses either through financial support or creating the enabling infrastructure. As a result, the likelihood that regulations will be crafted in such a complacent manner that favours the vested special interests of the companies or environmental groups who sponsored the regulatory institution. The economic and legal hurdles involved in developing regulations is another reason why direct environmental regulation might become unnecessary in the mitigation of risks associated with any activity such as shale gas extraction through HVHF.

The cost involvement from the investigatory stages of certain issues that need to be addressed through policy intervention is huge. This might create a situation whereby regulatory institutions will be tempted to source external funding from firms and private institutions. Where this is the case, regulatory institutions then often fall prey to the whims and caprices of these firms. This investigatory requirement is crucial because, without this, the policy

[149]Iringe-Koko, N. (2014). Balancing commercial interests with environmental and socio-economic responsibilities in the Nigerian oil and Gas Industry, Grosvenor House Publishing Ltd, United Kingdom p.83.
[150]Ruven, C. F & Leonie, R. (2016). Shale gas extraction, Precaution and prevention: A conversation on regulatory responses." *Energy Research & Social Science*, Volume 20 pp.131-141.

intervention might be challenged and reversed as having no legal justification.[151] In the long run such costs incurred are borne by the final consumer in terms of pricing regulation. Direct regulation also has the tendency to limit new participant's entering into the market. When regulation becomes too robust and demanding, new entrants are limited in that they do not have a level playing field with their old counterparts to compete. It therefore negates the very essence of a competitive liberalised market.

As this thesis is about law and policy with a view to developing a framework for environmental regulation and liability in mitigating shale gas risks, this thesis specifically argues for an indirect or self-regulatory system to deal with the existing problems of direct regulation as mentioned earlier. It will bring out possible incentives of self-regulation in addressing where liability should lie in circumstances where operators have observed the prescribed regulatory guidelines. The identification of environmental liabilities as a complement to environmental regulation in mitigating shale gas risks allocates a moral responsibility; the responsibility is required for effective reparation, and the economic valuation provides arguments to claim compensation, seek remediation in all the ramifications of resource extraction. This is because there has been no extensive study conducted regarding the complementary role of environmental liability to regulation.

Moreover, within the extractive industry, technological advances are projected to increase. This increase in technologies is said to be sparked off by the increase in world population and the need to satisfy world energy needs.[152] Without a well-defined environmental liability system that can foreclose the current dash for immature technologies which a direct form of regulatory response might not be able to address holistically, this thesis lays the foundational argument for an indirect or self-regulatory approach through the strengthening of liability systems in making regulation effective in risk mitigation.

Regulation or regulatory responses could be adversely affected and become futile where creators of harms know that they could escape liability due to certain existing legal exceptions and uncertainties inherent in some legal frameworks. However, an indirect or self-regulatory approach can foreclose the possibility for operators of such risk promoting activities to escape liability. Thus, uncertainties surrounding where the residual liability should lie is defined. How this should work in principle is simple. The role of making safety guideline requirements towards avoiding the occurrence of harms should be left with the industry even though the regulatory agency drafted this rules and guidelines in principle. Industry players determine whether to go beyond the level of cement required for the well casing and the periodic baseline water testing before, during and after drilling operations, should be the legal duty of the operator in principle, even though in practical terms the regulatory institution makes the rules for governing their operations.

Why this legal shift is required is that if there is a negligence claim against such an operator, the operator cannot shield themselves from liability on grounds that they have adhered to the standards laid down by the regulatory body. Therefore, the indirect or self-regulatory style of regulation re-enforces a strong liability system based on the precautionary principle[153] and forces the operator to anticipate risks and proffer solutions ahead.

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[151]Ibid.

[152]See supra Andres J. C. *et al.,* (2018) foot note 144 at p.78.

[153]See supra Benjamin, J. R; & Stephen, W. (2006) footnote 26 (Discusses the aim of the precautionary Principle. It was argued in that Paper the principle aims to help law and policy makers to reach decisions in cases where scientists are uncertain as to the potential environmental impacts of a given activity).

By strengthening the liability system through self-regulation such that the residual liability remains with the operator even where safety guidelines have been followed, it arguably erodes the present idea whereby the measurement for effectiveness of regulation must continue to depend on the degree of compliance level of those regulated. Rather, what self-regulation will do is to change the status-quo whereby the measurement of regulatory and liability system effectiveness would transcend to the ability of an operator to improvise or bear additional cost voluntarily in devising safety guidelines for mitigating risks the operator understands more than the regulator

Thus, in a growing world like ours where technology is developing more rapidly than the available safety measures, it is imperative to devise other forms of strategies whereby liability would also remain with the operator of risky activities. To this end, it is the argument of this thesis that if the prescriptive safety guidelines are compiled by the industry, the issue of operators being shielded from liability where they have complied with the prescribed rules they made is no longer an issue.[154] This thesis argues that industry players who invent technologies often perceive that they will be shielded from liability if they observe all available safety guidelines that govern resource extraction activities as prescribed by direct regulation. As a result, there is the dash to introduce technologies that are not environmentally friendly among better alternatives.

The presence of information asymmetry makes direct regulation significantly susceptible to the prevailing uncertainties and complexities as mentioned above already. These complexities and uncertainties make even the most sophisticated regulation lacking. The issue of regulatory capture or subversion would also be compensated by self-regulation especially for issues relating to safety standards. Essentially, whether a tool, or a combination of tools, is ideal depends on the nature of risk that the regulatory agency seeks to mitigate. To this end, policy makers could adopt the properties of self-regulation alongside direct regulation and liability standards to ensure that all nature of harms to environment and health is reduced. When deployed effectively, it fosters responsible shale gas development, transfers the costs implication involved in making regulation to the party best able to bear them. Further, it ensures optimal activity levels and promotes a guaranteed level of risk-taking for comprehensive environmental preservation.

[154]McDuffie v. Watkins Glen International Incorporation 833. F, Supp. 197, (W.D.N.Y., September 3, 1993); See also, Johnson v. Smith, 2006 N.Y. Misc. Lexis 2618 at 37-38 (City Ct, of New York (Jefferson County) September 8, 2006).

Chapter 3

3. The Activity of Shale Gas Development, Its Environmental and Health Impacts

In issues of liability and regulation in whatever form it may be enforced for the damage caused to the environment and health of human, a special place is occupied by the remedies available for shale gas accidents as it stands in today's energy extractive industry. This regulatory regime that is being argued for by many, including this thesis, for the governance of the operations and establishment of liability for extractive activity's damage began from a dual perspective.

First, perspectives range from the reduction of energy sources that characterise some regions of the world, the shale gas boom represents a definite solution and perspective.[155] Second, we must not neglect the serious risks in the long term to which both humans and the environment will be confronted with while harnessing these shale resources through hydraulic fracking technique.

Such risks are linked to the possibility of contamination and added stress to the existing water scarcity that confronts the world today or the dispersed nature of risks that results in air pollution to personnel and those living around shale gas sites. Thus, it is the assertion of this thesis that the exploration and extraction of shale gas should be strictly regulated. Furthermore, it should be strictly monitored to forestall accidents whose effects would leave a transgenerational impact.

Despite all the safety measures which industry claim would guarantee a safe delivery of shale gas exploitation, there are still increased frequency level of risks in terms of water contamination. Therefore, it appears there is a need to question the liability and regulatory systems applicable for shale gas extractive activity. Having said that, it is imperative the reader understands the technical aspects of fracking and the associated potential as well as the highly probable risks. As such, this Chapter illustrates both the technical aspects of hydraulic fracking and its impacts on environment and health.

On one hand, these technical aspects of fracking are only examined in brief since this is not a vital ingredient of this thesis. On the other hand, this Chapter has carefully identified the various negative environmental, health and social aspects that fracking operation presents. This thesis in its discussion often drew a comparison between these negative impacts with conventional natural gas extraction. It corroborates the positions of other literatures that have asserted that these impacts are not in any way different from what happens in the context of conventional natural gas extraction. However, the present work share the assertion of other articles that water contamination seems to be a unique risk to fracking. This position is not because the magnitude is different from the conventional water contamination issues. Rather this work relied on a frequency level of occurrence and the fact that water contamination could result from so many sources and reasons during drilling. This work provides a statistical representation of various water contamination incidents in the U.S alone since the inception of fracking as well as identifying four diverse ways whereby water contamination could occur from fracking which will be examined later in this section. From this, it appears that the 'predominance' with which water can be contaminated in unconventional oil and gas

[155]Tiemann, M & Vann, A. (2013). Hydraulic fracturing and safe drinking water Act issues In: Ferguson, S & Gilbert, M.T. Hydraulic fracturing and shale gas production: Issues, proposals and recommendations *Energy Science, Engineering and Technology,* Nova Science Publishers, Incorporation, New York, p.29-30.

extraction through the technique of fracking is more frequent when compared with conventional gas extractive technique.

Thus, on the strength of these factors and the evidence, the present research categorised the issue of water contamination associated with fracking as a unique risk. Lastly, this Chapter will carry out a comparative analysis of the alternative forms of fluid based hydraulic fracturing by identifying the advantages and disadvantages of each. Based on this analysis, the work drew an inference as to why the water-based hydraulic fracking was chosen amongst the alternatives which appears to be better and less environmentally exerting.

3.1 Introduction

The high permeability that characterise conventional mineral formations contribute to the formation's ability to retain abundant deposits of natural gas unlike shale that have low permeability. Hydraulic fracturing is therefore an engineering treatment performed to low permeable formations/reservoirs to strengthen communication underground within the gas reserves and enhance productivity. The ability to produce natural gas from shale deposits requires several steps in addition to hydraulic fracturing. These steps among others include road and well pad construction, drilling, well completion, production, abandonment and reclamation. These steps are characterised by potential environmental effects.

For those living near hydraulic fractured wells, there exist documented negative impacts. A systematic review reveal that 84% of public health studies gives an indication that there are public health hazards, elevated risks, or adverse health outcomes.[156] Similarly, 69% of studies conducted on water quality contained findings that suggests potential, positive association, or actual incidence of water contamination.[157] Further, 87% of air quality studies reveal findings that suggests elevated air pollutant emissions and/or atmospheric concentrations.[158] As the negative impacts of fracking have become something that is accepted by opponents and proponents as existing and clear, scholars have begun to seek the importance of devising effective regulations, policy interventions and a robust liability system to achieve the sustainable development of the oil and gas sector. Thus, policy makers and all stakeholders need to take account of the regulatory and complementary dimension, liability would have to regulation when making decisions[159] regarding the mitigation of fracking risks and impacts that will be discussed further in this Chapter.

On the reverse side, fracking's public policy benefits are obvious. First, increasing industry use of hydraulic fracking provides diversity to the sources of domestic energy that has made countries like the U.S non-reliant upon imported oil from politically unstable countries.[160] Second, abundant natural gas from shale as a cleaner burning fossil fuel supports the argument that any country who shifts from coal to natural gas will have a quicker decline in Greenhouse Gas (GHG) emissions as a result of cleaner burning fossils in the generation of electricity

[156]Hays, J & De Melo-Martin, I. (2014). Ethical concerns surrounding unconventional oil and gas development and vulnerable populations. *Rev Environ Health*, 29, pp.275 [Online] www.scopus.com/record/display.uri?eid=2-s2.0 84915775768&origin=inward&txGid=e8bc5ae37dcebf6a22d31ee6ebc42d47 (Accessed 12/07/2018)

[157]Evensen, D. (2016). Ethics and "fracking": a review of (the limited) moral though on shale gas development, *WIREs Water*, 3.

[158]Neville, K.J. *et al.,* (2017). Debating unconventional energy: social political, and economic implications. *Annual Review Environmental Resources*, 42 pp. 241-266.

[159]Evensen, D. (2015). Policy decisions on shale gas development ("fracking"): The insufficiency of science and necessity of moral thought. *Environ Val*, 24 pp.511-534.

[160]Global Insight HIS. (2009). Measuring the economic and energy impacts of proposals to regulate hydraulic fracturing. *Report Prepared for the American Petroleum Institute.*

power.[161] Third, shale gas operations could result in economic development positives like the creation of infrastructure, well-paying jobs, revenues and taxes for affected local governments.[162] Having said this, it is important to take a quick cursory look at what hydraulic fracking is and the associated impacts.

Fracking as it is fondly called by industry participants means the merging of cutting edge technologies which include: advanced high pressure, high volume hydraulic fracturing, and often horizontal drilling, and it has been used worldwide.[163] Fracking techniques entail the injection of a mixture of water, sand and synthetic chemicals into a borehole under high pressure to create fractures around the surrounding rock layers. The purpose is to produce channels for oil and natural gas to migrate freely. The sand, as part of the mixture that is left behind, keeps the fractures open.[164] Boreholes are drilled comprising of well heads above-ground tubes, valves that are attached to underground well, tanks and other equipment. This is done on the well pad.

Multiple wells can be drilled on one pad covering typically an area equivalent to about three hectares.[165] The well casing is inserted inside the borehole which serves as a seal for surrounding rock and the groundwater contained therein.[166] Fracking as a technique for extracting oil and gas resources is not new in general. However, the technique has only been used to extract oil and natural gas from conventional wells until recently that is, in those surrounding naturally porous rocks like sandstone, where fluids find it easy to flow, and fracking is used to stimulate recovery in situations when extraction becomes a challenge.

The extraction of unconventional oil and gas (i.e. trapped in tight low permeable rocks such as shale) through fracking techniques has only taken place on a large scale within the last decade in the US. While the chemical characteristics of shale gas are no different from those of natural gas extracted in other natural formations, the processes involved in its production is very distinct. Contrary to the requirement of a vertical drilling technique used for conventional wells, fracking in shale requires horizontal drilling which is more complicated. Huge numbers of wells are drilled as the gas cannot migrate far distances to the source for extraction. As a result, millions of gallons of water mixed with synthetic chemicals are used to aid these gases to migrate to the wellhead.

3.2 Shale Gas Extraction Process Stages

Broadly there two major stages involved in the extraction of natural gas from both conventional and nonconventional reserves, namely: well pad construction and well completion. Of note, the nomenclature may differ. Whilst unconventional gas fracking will call the first stage well pad construction, conventional extraction may call it well construction. They are as follows:

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[161]Engelder, T. (2011). Natural gas: should fracking stop? *Nature, 477, pp.271-275.*

[162]Sovacool, B. K. (2014). Cornucopia or curse? Reviewing the costs and benefits of shale gas hydraulic fracking (fracking). Renewable Sustainable Energy Reve. 37, pp. 249-264.

[163]Meng, Q *et al.,* (2016). 'Fracking' Handbook of climate change mitigation and adaptation, pp.1-14

[164]The Royal Society and the Royal Academy of Engineering, (2012). Shale Gas Extraction in the UK: A Review of Hydraulic Fracturing. [Online] http://royalsociety.org/policy/projects/shale-gas-extraction/report/ [Accessed December 5, 2016].

[165]Ibid.

[166]Broderick, J. A *et al.,* (2011). 'Shale Gas: An updated assessment of environmental and climate change impacts'. A report by the *Tyndall Centre*.

3.2.1 Well Pad Construction

A prepared area on the surface is required for the horizontal wells being used for extracting gas and oil from shale formations. That area is known as a well pad. It serves as a stable base for the accommodation of a drilling rig, water-storage tanks, retention ponds, loading areas for water trucks, associated piping, and pumping and control trucks.[167] Once the well construction is completed, the pad serves as a location for establishing the wellhead and other equipment used for production. Well pad size is dependent on the depth of the well as well as the number of wells to be drilled on site. Ordinarily, four to six wells or more can be drilled on an individual well pad with a footprint of around 260ha per unit.[168]

3.2.2 Well Completion

Well completion involves several steps necessary to assemble the downhole casing, tubulars, and equipment to effectively exploit oil and gas from a well once it is drilled. It also involves the processes of creating perforations in the production casing as well hydraulic fracturing of the formations. Consequently, the following sections illustrate the different processes of drilling a well and its completion.

3.3 The Various Processes of Unconventional Oil and Gas Extraction

3.3.1 Drilling

Most shale resources are situated at depths of one thousand eight hundred metres or more below ground level and can be relatively thin.[169] For example, the Marcellus Shale formation is between fifteen and sixty metres thick, depending on the location.[170] Hence, to ensure efficient extraction of gas from such a thin layer of rock requires the use of the horizontal drilling technique through the shale as shown in figure 1 (below). This is achieved by drilling vertically downward first until the drill bit reaches a distance of around two hundred and seventy five metre from the shale formation.[171]

At this stage, directional drilling is introduced to create a gradual ninety degrees curve for the wellbore and the drilled hole that is bounded by the rock face to become horizontal as it reaches optimal depth within the shale. Then the shale formation is drilled horizontally for one and a half thousand, metres or more for the wellbore to follow the formation.[172] From a single pad, multiple horizontal wells that can access different parts of shale formations can be drilled thereby reducing the footprint of operations and enabling a large area of shale to be exploited from a single pad.

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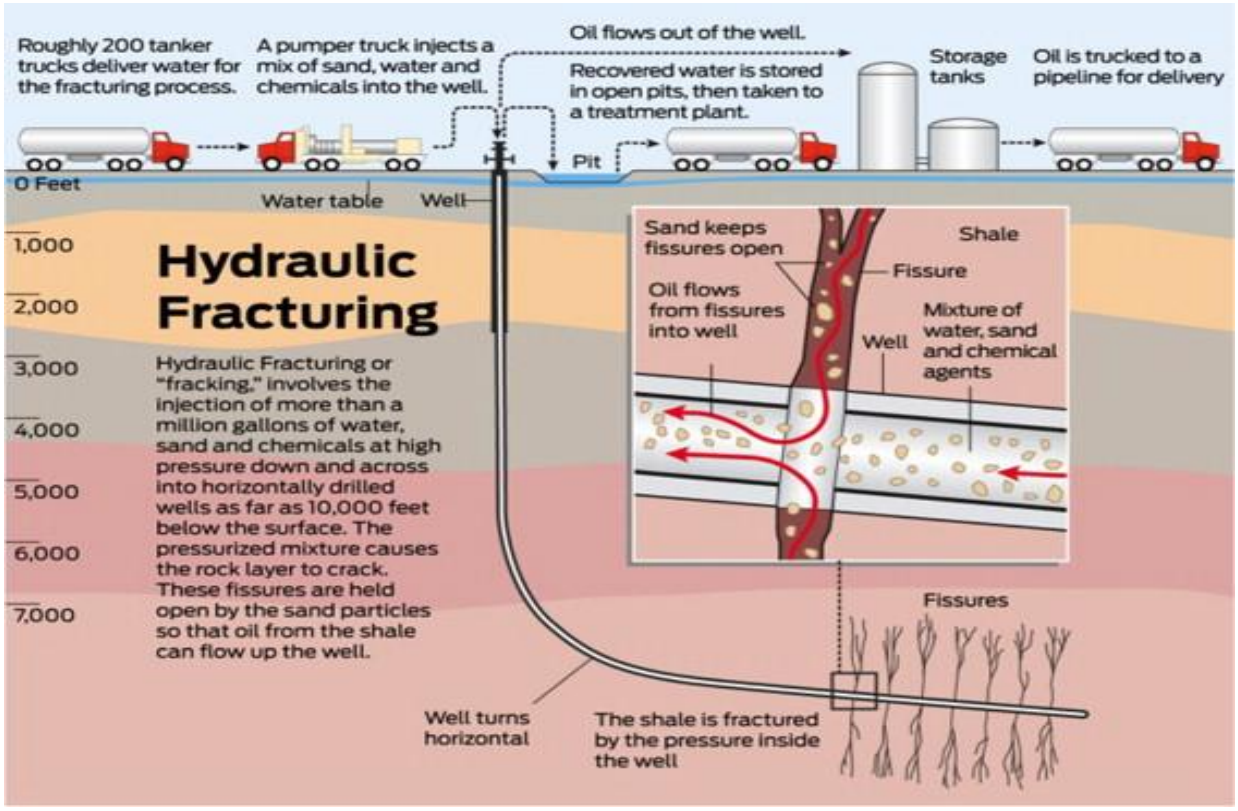
[167]Corrie, W. C *et al.,* (2012). Introduction: The technology and policy of hydraulic and potential environmental impacts of shale gas development, *Environmental Practice*, 14, p. 250. www.doi; 10 1017/s1466046612000415.
[168]Ground Water Protection Council and All Consulting. (2009). Modern shale gas development in the United States: A Primer. *US Department of Energy, National Energy Technology Laboratory*, Washington, DC, 116 pp. [Online] Available http://www.netl.doe.gov/technologies/oil-gas/publications/epreports/shale_gas_primer_2009.pdf [Accessed December 12, 2016).
[169]Qiang, W *et al.,* (2014). Natural gas from shale formation-The evolution, evidences and challenges of shale gas revolution in United States, *Renewable and Sustainable Energy Reviews* Volume 30 pp.4
[170]Ibid
[171]See supra Gray, W.B & Shimshack, P. (2011) footnote 118.
[172]Thomas, M *et al.,* (2018). Shale gas production costs: Historical developments and Outlook. *The Extractive Industries and Societies*, in press, Corrected proof, available online.

Figure 1. Typical configuration for a horizontally drilled, hydraulic fractured shale gas well.



Source Reference: Shale Gas Fracking-the facts and figures. *The Guardian;* (2012); What is Hydraulic Fracking? Propublica, 2012 [Online] https://ars.els-cdn.com/content/image/1-s2.0-S1364032113006059-gr2.jpg (Accessed 21st June 2018).

3.3.2 Casing Installation and Perforation

Once drilling is done satisfactorily, the installation of steel casings at the wellbore to prevent the migration of contaminants to the freshwater aquifers is required. Although, drilling can be stopped in the event of potential contamination during the process to allow the installation of steel casing piping at the wellbore, when the wellbore reaches depths below the deepest freshwater aquifer, casing is installed to avoid the water from being polluted because of the drilling process. At the centre of the casing, cement is pumped down and forced up the annulus between the casing and the borehole.

Several layers of protection through freshwater zones are provided as one or more intermediate strings of casing may be installed in these deep wells at some point. Production casing is run through the entire length of the borehole and is cemented in place from the end of the horizontal borehole to at least a point exceeding the curve where the well is vertical. This process is done after the well has reached its full horizontal length to prevent leakage of natural gas from the well to the rock demarcating the formation from the surface, and to prevent migration of natural gas to the surface through the annulus.

Perforation of the section of the well through the shale formation is carried out with the aid of a perforating gun that detonates explosive charges, producing small holes in the well casing, which extend a short distance into the surrounding shale formation. This is carried out to

ensure the easy pumping of hydraulic fracturing fluids into the shale and the subsequent flow of salt water out of the shale into the well, along with natural gas and oil.[173]

3.3.3 Hydraulic Fracturing

Whilst little gas will flow freely into the well after perforation, fracture networks must be created in the shale to enhance the steady flow of natural gas. These fracture networks are created through hydraulic fracturing. Typically, in this process 8,700-20,820 m^3 (2.3-5.5 million gallons) of fluid composed of 98%-99.5% water and proppant (normally sand) are pumped at high pressure through the perforations.[174] The fracking fluid may contain 0.2%-2.0% volume of a mixture of chemicals that enhances the fluid properties.[175] These chemicals play different functions: there are acids that are used to 'clean' the perforations for efficient natural gas flow; biocides used for preventing the growth of organisms which clog the shale fractures; corrosion and scale inhibitors meant for protecting the integrity of the well; gels or gums that boost viscosity to the fluid and suspend the proppant; and friction reducers that improve the flow of fluid to the transmission of pressure from the pumps at the surface to the bottom of the wellbore and on to the deepest parts of the induced fractures.[176]

Usually vertical fractures are created due to hydraulic fracturing that take place in the shale. These fractures extend away from the perforated horizontal wellbore connecting pores and existing fractures in the shale creating a pathway for fluids to flow. The proppants which are pumped into the wellbore under high pressure keep the fracture opened once the pressure is reduced and fluid flows back out of the well.

Individual wells must go through hydraulic fracking in multiple stages, starting from the farthest end of the wellbore, to increase productivity of each well. Accordingly, once all hydraulic fracking is completed, plugs which were used to isolate each fracking stage are removed.

After the post-fracture exercise, fluids (commonly known as flow back water) flow to the top of the well and immediately the surface valves of the well are opened. Aside from the proprietary blend of chemicals present in the hydraulic fracking fluid, it may also contain other constituents naturally present in the reservoir, including: Naturally Occurring Radioactive Materials (NORMS). The composition of the chemicals of the flow back water depend on the formation and the time after well completion. The initial flow back water looks like the fracturing fluid but later the combination of the flow back water looks more closely like the existing organic compounds found naturally in the formation.

In certain instances, the fluid that flows out to the surface can be used again in subsequent fracking operations. However, this is dependent on the flow back water quality and the economics of management alternatives. If the flow back water is not used again for subsequent

[173]Cooper, J *et al.,* (2018). 'Social Sustainability Assessment of Shale Gas in the UK' *Sustainable Production & Consumption,* Volume 14, pp.1-20.
[174]Szolucha, A. (2018). Anticipating Fracking: Shale gas developments and the politics of time in Lancanshire, UK. *The Extractive Industries & Society,* Volume 5, Issue 3 pp.348-355.
[175]Ibid.
[176]Fernando, C. A *et al.,* (2018). Sustainability lessons from shale development in the United States for Mexico & other emerging unconventional oil and gas developers. *Renewable & Sustainable Energy Reviews,* Volume 82, part 1 pp.1320-1332.

fracking operations, it is managed through disposal either into underground injection tanks or treated to a certain safe level for disposal into the domestic watercourse.[177]

3.3.4 Actual Production Process

At this juncture, recovered gases from the well during production are sent to small diameter gathering pipes that connect to larger ones that collect gas from a network of production wells. Also, oil and brines are recovered in large tanks on site and trucked off the site. The production lifetime of an average shale well is not fully determined because large-scale shale gas and oil production only started relatively recently. However, it is generally accepted that compared to conventional reservoir rock formations, unconventional shale gas wells experience more rapid declining production rates.[178]

As a result of this uncertainty, once the initial production phase has lapsed and it is necessary to increase productivity, the shale gas well may be recompleted (i.e. cleaned and hydraulic fracking will take place) either multiple times or as occasion demands to improve productivity.[179] In the event that the well no longer produces at an economic rate, the wellbore is filled with cement to avoid leakage of reservoir fluid into shallow formations or to the surface after the wellhead is eventually removed. Reclamation of the surface is carried out and the site is returned to the land surface rights owner. Having reviewed the processes involved in the exploration and exploitation of natural gas from unconventional reserves, it is pertinent to identify some of the novel impacts this technique presents.

3.4 An Overview of the Environmental Impacts Associated with Shale Gas Development

Natural gas from shale is one of a number of types of unconventional fossil fuel. Coal Bed Methane (CBM) and methane from Underground Coal Gasification (UCG) are the other types of unconventional fossil fuels. The extraction process of CBM resembles the one which is used for extracting shale gas, and often involves fracking,[180] whereas UCG entails the igniting of unmined coal seams in-situ to gasify the coal.[181] In as much as the techniques have commonality in the issues they present, each is distinct in terms of impacts, and this section concentrates specifically on shale gas.

The environmental, health and social impacts of fracking are among the main concerns surrounding the technology. This section will examine the most important local environmental impacts, such as water contamination and earthquake risks. Further, this section will also consider the current evidence as it affects public health and wellbeing. It suffices to note too that the environmental impacts linked to shale gas and oil development occur at both the immediate local and national levels. These may include impacts to water quality and availability, local air quality, seismic events, climate change and the local community.

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[177]Veil, J. A & Clark, C. E. (2011). Produced water volume estimates and management practices. *SPE Production & Operations* 26~3:234–239.

[178]Mason, J. (2011). Well production profiles for the Fayetteville shale gas play. Oil & Gas Journal.

[179]Zendehboudi, S & Bahadori, A. (2017). Chapter Five: Shale Gas Processing, Shale Oil & Gas Handbook, pp.153-192.

[180]The Department of Energy and Climate Change DECC Website, (2010). "The unconventional hydrocarbon resources of Britain's onshore basins – coal bed methane (CBM), [Online] Available https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/66171/promote-uk cbm.pdf. (Illustrating in detail the extraction process of CBM through fracking technique).

[181]Kuchler, M. (2017). Post conventional energy future: Rendering shale gas resources governable, *Energy Research & Social Science,* Volume 31, pp.32-40.

3.4.1 Water Quality Impacts

The fact that drilling a well using fracking involves the injection of water and chemicals at high pressure into the ground to open rock for the release of natural gas, accounts for series of challenges for protecting water resources. Thus, much of the oppositions surrounding shale gas extraction centres on water related issues.[182]

The issue of methane and fluids from hydraulic fracking operations causes concerns over potential drinking water contamination and adverse effects on its quality. The probable pathways for such drinking water contamination emanates from improper disposal, underground leakages from wellbore to groundwater aquifers or leakages of hydraulic fracking fluids to surface water bodies caused by accidents. It has also been argued that the possibility for fluids to flow from another pathway aside from the existing wellbore within the shale play through thousands of feet of overlaying rock into the drinking-water aquifer.[183] Nevertheless, shallow shale formations may be vulnerable to this direct connection, as it has been suggested by the groundwater investigation carried out in Pavillion, Wyoming in 2011, where as little as 128 m separated gas deposits from drinking water reservoirs.[184]

Contamination may also occur in deep formations due to defects in the wellbore. These defects may happen while installing the well if the cement in the annulus is not of sufficient quality, or methane can migrate from the shale reservoir up the outside of the wellbore to shallow aquifers where it could dissolve and find its way into the drinking water. When depths are shallow, casing defects could provide another pathway where contamination may occur, giving room for gas to flow through the wellbore to the aquifer. One of the largest documented instances of contamination occurred in Bradford County, Pennsylvania, after a well had been drilled but prior to any fracking; this was caused by faulty well construction.[185]

According to some commentators, in addition to faulty well constructions, wells that are not cased or abandoned may result in the migration of methane.[186] Among various sources of contamination, intentional dumping or accidental spilling of flow back water into adjacent water reservoirs is the most easily preventable cause. The overflow that occurs in retention ponds during heavy downpours can also cause accidental spillage.

Flow back water contains pollutants such as NORMs, from mineral formations as well as the chemical additives contained in the hydraulic fracking fluid. Their significant concentrations may pose serious health concerns. At the commencement of shale gas developmental

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[182]Warner, N. R *et al.,* (2012). Geochemical evidence for possible natural migration of Marcellus formation brine to shale aquifers in Pennsylvania, *Proceedings of the National Academy of Sciences, 109,* pp. 11961-11966

[183]Toothill, A. (2013). Fracking in the UK: The storm gathering over our countryside, Amazon.co.uk, Great Britain. In: Ferguson, S & Gilbert, M.T. Hydraulic fracturing and shale gas production: Issues, proposals and recommendations *Energy Science, Engineering and Technology,* Nova Science Publishers Incorporation, New York, p.29-30.

[184]US Environmental Protection Agency ~US EPA, (2011). *Investigation of Ground Contamination Near Pavillion, Wyoming* ~Draft! EPA600/R-00/000. US EPA, Washington, DC p.60 [Online] Available at Http://Www.Fossil.Energy.Gov/Programs/Gasregulation/Authorizations/2011_Applications/Exhibits_11-162-LNG/54.1_EPA_Reportonpavillion_Dec-8-2011_-_.Pdf ~Accessed December 9, 2016. [Accessed 12 May 2017]

[185]Pennsylvania Department of Environmental Protection ~PA DEP! (2011). DEP Fines Chesapeake Energy More Than $1 Million: Penalties Address Violations in Bradford, Washington Counties. PA DEP, Harrisburg, PA [Online] http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id517405&typeid51[Accessed 9/12/2016).

[186]Osborn, S.G *et al.,* (2011). 'Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing', *Proceedings of the National Academy of Sciences,* USA 108~20!8172–817.

operations in the U.S, there were no federal drinking water standard limits for methane. It is however a hazard in water in that at significant concentrations it can volatilise and collect in houses and possibly result in suffocation or cause fire explosions. It is worth noting however that in shallow formations and freshwater aquifers, methane may naturally occur. Thus, methane migration might not only be a product of defective wells or a defect connected to the shale reservoirs whilst hydraulically fracking the well.

3.4.2 Water Availability and Consumption Impacts

In as much as hydraulic fracking involves a multi stage process with water being used in most of these stages, the bulk of the water is ultimately consumed during the drilling and completion phases. Large volumes of water, between 8,000-20,000 m^3 (an equivalent of 2.3-5.5 million gallons), are needed to frack each well.[187] Additional water, from 700 to 1,200 m^3 (190,000-310,000 gallons), is used for drilling and cementing works during the construction of a shale well pad.[188]

A well that has a production life span of 30 years and, during this period, the well is hydraulically fractured say three times, the construction and production of shale gas would require 27,000-64,000 m^3 equivalent to 7,000, 000 to 17 000, 000 gallons of water per well.[189] However, the number of times a shale formation might be re-fractured to extend the economic life of that shale well is not known because of the limited production history of most shale plays. Once the gas is produced, it is sent for processing before use by the final consumer. During each of these phases, water is consumed with the most significant non-production consumption possibly happening during the end use.

The quantity of water required in hydraulic fracturing process depends on the nature of shale gas and the fracturing operations, such as the depth and length of the well, the design of the fracturing job and the properties of the fracturing fluid. Natural gas combustion can be done directly without additional water being consumed. Where the end use of the gas is a vehicle tank, it is most likely to be compressed via an electric compressor. Such electricity compression involves at least 0.6-0.8 litres of water consumption which makes the total consumption vehicle life cycle 1.0-2.3 litre per.[190] In fact, the water vapour created during the end use combustion process does not automatically make the resource useful until it has gone through the hydrological cycle.[191] Figure 2 (below) graphically illustrates the water lifecycle in hydraulic fracturing.

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[187]Clark, C. E *et al.,* (2011). Life-Cycle Analysis of Shale Gas and Natural Gas. ANL/ESD/11-11. Argonne National Laboratory, Argonne, IL, p. 38 (2011). [Online] Available http://www.transportation.anl.gov/pdfs/ee/813.pdf ~ [Accessed 10/12/2016].

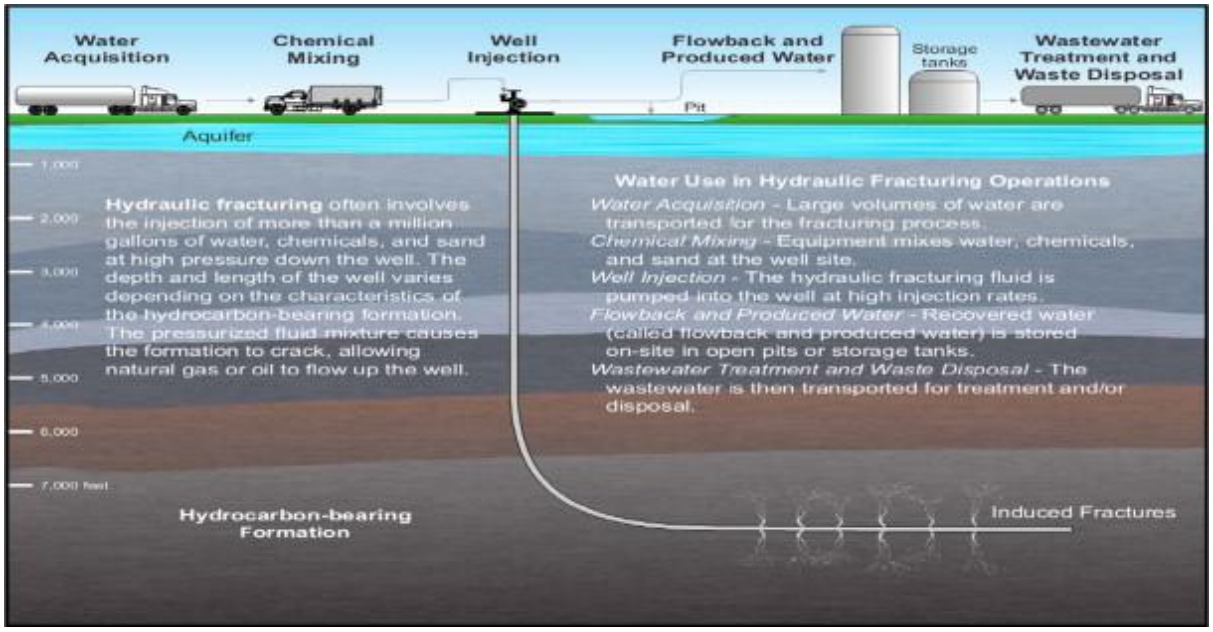
[188]The Coal Authority Website, "The Coal Authority (Undated) Underground Coal Gasification In The UK" [Online] Available http://coal.decc.gov.uk/en/coal/cms/publications/mining/gasification/gasification.asp (Illustrating in detail the extraction process of ucg as type of unconventional fossil fuel) [Accessed June 20, 2016]

[189]Satterfield J. *et al.,* (2008). Managing water resources challenges in select natural gas shale plays. GWPC Annual Forum. Oklahoma; US Environmental Protection Agency, 2(011). Plan to study the potential impacts of hydraulic fracturing on drinking water resources Washington DC.

[190]King, C. W & Webber, M. E. (2008). Water Intensity of Transportation. Environmental Science & Technology 42~21! 7866–7872.

[191]Wu, M. M *et al.,* (2011). 'Consumptive water use in the production of ethanol and petroleum gasoline' Update ANL/ESD/09-1. Argonne National Laboratory, Argonne, IL, Pp. 100. [Online] Available http://www.greet.es.anl.gov/publication-consumptive_water ~, [Accessed 02/12/2016].

Figure 2. The water lifecycle of hydraulic fracturing.



Source Ref: EPA Plan to study the potential impacts of hydraulic fracturing on drinking water resources, U.S Environmental Protection Agency, Washington, (2011) [Online] https://www.sciencedirect.com/science/article/pii/S1364032113006059#bib275 (accessed on July 13, 2018).

Nevertheless, water that might potentially be used for shale gas wells may be derived from groundwater aquifers, surface water reservoirs (lakes, rivers, ponds), municipal supplies, reused waste water from industry or water treatment plants and recycled water from earlier fracturing operations. The point to note here is that such withdrawals will result in reduced stream flows or the depletion of groundwater aquifers. The impacts on water vary significantly depending on the location of withdrawals and their seasonal timing. This often accounts for the difference between high impact and no impacts on other users. An evaluation of the impact of such water withdrawals on local communities and the local environment both in the short and long term is the most reasonable approach to assessing water usage not only for shale gas development but other users. A key distinction regarding this water use is whether it is sustainable.

All these issues must be considered when determining water availability and the consumption of water associated with shale gas developmental operations. However, the proponents of shale gas have claimed that a well will normally return 5%-20% of the original volume of fluid to the surface within the first 10 days as flow back after fracking.

Subsequently, an additional volume of water as flow back, equivalent from 10% to almost 30% of the total injected volume, will return as produced water over the life of the well.[192] According to these claims, one further proof of the insignificant impact shale gas development has on water consumption, is the fact that operators reuse 95% of the flow back.[193]

[192]Mantell, M. E. (2010). Personal communication between M.E. Mantell, Chesapeake Energy, and C.B. Harto, Argonne National Laboratory, Washington, DC.
[193]Tian, L. *et al.,* (2014). Stimulating shale gas development in China: A comparison with the US Experience energy policy Volume 75, pp.119-116.

Hence, the ability to reuse water is highly dependent upon the quality and quantity of the water as well as the availability and affordability of water management options. In addition, the fact that flow back water is not able to be reused and thus are disposed of in Class II injection wells or used as dust suppressant is an added impact on the water consumption issue associated with HVHF operations that has an indirect effect on other freshwater users. In sum, water consumption for hydraulic fracking will grow with the increasing number of wells and shale gas production across any country where shale gas will be developed.[194]

3.4.3 Local Air Quality

Air pollution is another impact associated with concentrated shale gas development. Shale gas extraction operations produce GHGs in addition to fugitive natural gas emissions, volatile organic compounds (VOCs) as well as hazardous air pollutants such as benzene. Drilling, hydraulic fracking and compression equipment, typically powered by large internal combustion engines, also results in significant emissions of sulphur and nitrogen oxides.[195]

The emission inventories of several states reveal that shale gas operations may worsen the levels of ozone and hazardous air pollutants found in the immediate areas of shale gas development. For example, the 2008 Colorado emission inventory showed huge emissions from anthropogenic sources accounting for 48% of VOCs, 18% of nitrogen oxides, and 15% of benzene.[196] These contributions notwithstanding, their actual impact is uncertain, since air quality within a development area depends on local conditions; hence, more comprehensive modelling and analysis is needed to fully appreciate these impacts. For example, an increased level of benzene emissions has been found near production sites.[197] However, their concentrations have been below health-based screening levels.[198]

Nevertheless, the report of the Intergovernmental Panel on Climate Change (IPPC) generally reached a consensus agreement that natural gas emits about half as much as carbon as coal when used in efficient power plants.[199] This consensus is also corroborated by the official reports of carbon emissions from fossil fuel combustion such as the IEA,[200] EIA,[201] and the U.S EPA.[202] These reports resonates the effect of carbon footprint (life cycle GHG emissions)[203] on climate change that arise from shale gas extraction.[204]

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[194]See supra Coglianese, C *et al.,* (2002) footnote 138

[195]Ibid

[196]Colorado 2008 Air Pollutant Emissions Inventory, (2012). CDPHE, Denver, CO. Colorado Department of Public Health and Environment ~cdphe! [Online] Available http://www.colorado.gov/airquality/inv_maps_2008.aspx [Accessed 12/12/2016]

[197]Alvarez, R. (2012). Air Pollution issues associated with unconventional natural gas and oil. EM, Magazine of the Air and Waste Management Association, Pp. 22–25

[198]Soeder, D. J. (2018). The Successful Development of Gas and Oil Resources from Shale in North America. *Journal of Petroleum Science & Engineering,* Volume 163 pp.399-420.

[199]Intergovernmental Panel on Climate Change, IPCC. (2006). Guidelines for national greenhouse gas inventories, *Geneva.*

[200]International Energy Agency. (2012). Global carbon-dioxide emissions increase by 1.0 Gt in 2011 to record high, *Paris.*

[201]U.S. Carbon dioxide emissions in 2009: A retrospective review. Washington DC, 2010.

[202]Inventory of U.S. Greenhouse gas emissions and sinks: 1990-2009, Washington, DC (2012).

[203]Wiedmann, T. & Minx J. (2008). 'A definition of carbon footprint' *C C Pertsova (ed.) Ecological economics research trends, Nova Science Publishers,* New York, pp.1-11.

[204]Wigley, T. (2011). Coal to gas: The influence of methane leakage. *Climate Change, 108*, pp.601-608*;* Schrag D. P. (2012). Is shale gas good for climate change? *Daedalus, 141, pp*72-80.

3.4.4 Induced Seismic Event Impact

It has been asserted that over 95% of injected water for hydraulic fracking, flows to the surface as flow back water which either can be reused for subsequent fracking or disposed in class II injection disposal wells.[205] Keeping in mind that these reuse option depends on the quality and quantity of the water, where the flow back water cannot be reused for industrial activity, it is sent for disposal at a Class II injection well. The challenge is that in areas where shale gas development takes place, there is often insufficient Class II disposal well facilities for such water wastes to be accommodated.

This increased disposal of hydraulic fracking fluid into Class II injection wells may be the cause of induced seismic events in such areas, contrary to the claims of the proponents of the technique that a properly located well will not cause earthquakes.[206] They assert that a series of factors must trigger seismic events at a disposal site, that earthquakes are a result of faults that exist nearby and must be in a near-failure state of stress, that the injection well must have a path of communication to the fault and that the fluid flow rate in the well must be at a sufficient quantity and pressure long enough to cause failure along the fault or system of faults.

Looking at the factors mentioned above, it suffice to say that the last factor goes to corroborate the argument that increased disposal activity is the catalyst that triggers seismic events. There are insufficient disposal wells to contain such large percentage of hydraulic fracking fluids that returns to the surface repeatedly within fracking sites. For example, on the one hand, the lack of available suitable geology in Pennsylvania has led to hauling flow back water to Ohio for disposal in Class II injection wells. On the other hand, studies have revealed that injection activities in Arkansas have been connected to nearby earthquakes.[207]

3.4.5 Community Impacts

The development of oil and gas like every other industrial activity is not exempted from its own share of local impacts. These industrial processes involve the use of heavy equipment. For example, hydraulic fracking requires hundreds to thousands of truck trips to deliver water as well as chemicals to execute the entire fracking processes. The intensity of traffic exerts unforeseen pressure on the local roads; such heavy loads were not contemplated during initial construction. This can result in congestion which might become a source of frustration to frequent local users. The movement of heavy equipment, in addition to normal rates of traffic, can also be noisy and visually unpleasant to residents. The value of local property, especially in residential areas, can be affected negatively due to the beehive of activities taking place around the area. Very few people might want to live around such potential risky and disturbing surrounding.

A clear example of a community impact caused by fracking was illustrated in the case between *Hamblet v. James Martin* in his official capacity as a Director, Office of Oil and Gas, West Virginia Department of Environmental Protection; Office of Oil and Gas and others.[208] In the

[205]See supra Bennett, A; & Elman, C. (2007) footnote 62.
[206]Ohio Department of Natural Resources (ODNR), March, (2012). Preliminary report on the Northstar 1 Class II injection well and the seismic events in the Youngstown, Ohio, Area. ODNR, Columbus, OH, p.24 [Online] Available http://ohiodnr.com/downloads/northstar/uicreport.pdf [Accessed December 14, 2016).
[207]Horton, S. (2012). Disposal of hydro fracking waste fluid by injection into subsurface aquifers triggers earthquake swarm in central Arkansas with potential for damaging earthquake. Seismological research letters 83~2!:250–260.
[208]Case No. 10-P-15 (Circuit Court of Doddridge County, W. Va., May 21, 2010).

case of Hamblet, the plaintiff, EQT, a production company holding a valid oil and gas lease executed in 1905 encompasses the property owned by Matthew Hamblet, filed a permit application with the West Virginia Office of Oil and Gas of the West Virginia Department of Environmental Protection (WVDEP) to drill a shale well with "horizontal leg into the Marcellus" Shale formation. However, on 7th of April 2010, the plaintiff submitted comments to the WVDEP complaining of a prior damage and disturbance to his property from at least four other wells in the area. He went further to complain that the erosion and sediment control plan was inadequate and that the proximity of drilling waste to surface water presented a failure to protect fresh water resources.

Although the WVDEP was satisfied with all the application requirements after an inspection was carried out, the plaintiff filed his "Petition for Appeal of Issuance of a Well Permit" on May 27, 2017, seeking to nullify the drilling permit and stating that the state regulators had not done enough to protect his land and environment. He claimed that EQT personnel were

> *"driving around and off the access roads, parking in the meadows in an unorganized way, taking more time than is reasonably necessary to construct the well site, leaving chemicals and trash all over the ground, allowing for the silting of creeks away of meadows and destroy creek lives and habitats."*[209]

Therefore, this kind of situation can contribute to enormous community impacts resulting in severe health and safety risks.

3.4.6 Climate Impacts

The contribution of shale gas extraction operations to climate change has been quite a controversial subject. Proponents claim that it presents positive benefits for the climate. As a result, this proposition has been supported to promote the idea that shale gas can provide a suitable transition fuel, allowing us to shift from carbon intensive fossil fuels to a cleaner energy mix. Advocates of this claim say that burning gas in power stations releases roughly half the carbon emissions of coal, making shale gas a more environmentally-friendly option compared to coal.

Nevertheless, advocates on the other side of the divide assert that the issue of climate change is challenging and enormous that even if we halve the emissions from coal, it will not be enough.[210] A study produced by DG Clima under the auspices of the European Commission, corroborated the fact that shale gas activities were more carbon-intensive than conventional gas and oil fuels.[211] The GHG emissions released when shale gas is burnt, adds to the increased levels in the atmosphere. Therefore, it cannot be considered as a low carbon source of energy and based on growing body of evidence, it could in fact be as damaging to the climate as coal.[212]

In 2010, GHG emissions were the highest in recorded history, taking atmospheric levels well over 350 parts per million (ppm) which is considered the safe threshold level to stabilise

[209]Ibid.
[210]Howarth, R *et al.,* (2011). "Methane and the greenhouse gas footprint of natural gas from shale formations", [Online] Available (http://www.sustainablefuture.cornell.edu/news/attachments/howarth-etal-2011.pdf) [Accessed 23/12/ 2016].
[211]Climate Impact of Potential Shale Gas Production in the EU", (2012). European Commission, DG Climate Action [Online] Available http://www.ec.europa.eu/environment/integration/energy/pdf/fracking%20study.pdf) [Accessed 8/05/2016]
[212]Ibid.

warming at around 2 degrees Celsius.[213] What this means is that a gradual transition promoted through a dependence on gas is no longer a viable option. The IEA illustrated that a global energy mix dependent on natural gas would result in atmospheric levels of GHGs at 650 ppm CO_2 – resulting in catastrophic consequences from the resulting, long term global temperature rise of more than 3.5 degrees Celsius.[214]

The impact of emissions from gas has resulted in concern at both the national and global level. Evidence through scientific research has suggested that shale gas could in fact be as damaging to the climate as relying on coal. This is because the methane released during the extraction process is quite unusual. Although evidence shows that unconventional gas extraction causes small emissions compared to the case of shale gas (0.2-2.9 percent of combustion emission).[215] Increasingly, fugitive emissions from methane are caused by 'flow back', returning to the surface, accompanied by large amounts of methane. Methane is likewise released through leaks, in processing, and during transportation. Nevertheless, these channels where methane is released can be limited using best practices but cannot be completely avoided.[216]

When compared to carbon-dioxide, methane is a much more potent GHG. Its contribution to climate change is 32 times greater than carbon-dioxide over a 100 year time frame and over shorter time frames, its impact is even greater. On average, 3.6-7.9 per cent of the total output of a shale gas well is lost through fugitive methane emissions.[217] In addition, the U.S National Academy of Sciences reported that it is likely that natural gas leakages at individual well sites is high enough when combined with leakages from down steam operations, to make the overall leakage exceed the 3.2 per cent threshold beyond which coal for at least some period of time.[218]

3.4.7 Land Contamination and Use

The drilling and fracking process also impacts on the landscape, and pollution can affect surface soil and sub-soil[219] because of contamination from the following:

- Chemicals from fracking can cause further toxic risk when mixed with naturally occurring hazardous substances underground; and
- Heavy metals and NORMS found underground, which can pollute the flow back liquid from the fracking process, or which can build up underground.

Like every extractive resource process, other aspects of the extraction process could be a conduit through which pollution may emanate: from tank and pit fire, explosions, well blowouts,[220] transport accidents, leaks and spills of methane, natural gas, and chemicals. In

[213]Shale Gas: (2011). A provisional assessment of climate change and environmental impacts". Tyndall Centre University of Manchester, p. 72 [Online] http://www.tyndall.ac.uk/sites/default/files/tyndallcoop_shale_gas_report_final.pdf [Accessed 23/11/2016].
[214]Ibid.
[215]Guo, M *et al.,* (2017). 'Catching environmental noncompliance in shale gas development in China and the United States. *Resource, Conservation and Recycling,* Volume 121 pp.73-83
[216]See supra Howarth, R *et al.,* (2011) footnote 210.
[217]Alvarez, R *et al.,* (2012). "Greater Focus Needed On Methane Leakage From Natural Gas Infrastructure" [Online] Available http://www.pnas.org/content/early/2012/04/02/1202407109.full.pdf (Accessed 6/06/2016)
[218]http://www.nature.com/news/air-sampling-reveals-high-emissions-from-gas-field-1.9982.
[219]Bamberger, M & Oswald, R. (2012) "Impacts of gas drilling on human and animal health", new solutions, Volume 22 Issue 1, pp.51-77.
[220]See supra Benjamin, J. R; & Stephen, W. (2006) footnote 26 at p.17.

April 2011, a Chesapeake well in Bradford County suffered a massive blowout. It was the onshore natural gas version of what happened to BP in the Gulf two years previously: a wellhead flange failed, and toxic water gushed uncontrollably from the well for several days before workers were able to bring it under control. Seven families were evacuated from their homes as 10,000 gallons of fracking fluid spilled into surrounding pastures and streams. Pennsylvania fined the company $250,000 – the highest penalty allowed under state law.[221]

The large number of wells used results in a vast area[222]being affected by fracking. Each individual well has several drill/pump heads, sludge ponds where flow back fracking fluids and water are stored, storage tanks and compressor stations. All these led to a high visual impact, noise pollution which impacts on residents, farmers, the natural habitat and biodiversity. In areas where the demand for land is high, the impacts on land caused by fracking could be a trigger for potential conflicts especially where population density is higher than in the U.S.[223]

3.4.8 Impacts on Population

In areas where the population density is high, and the possibility that shale gas wells may be geographically proximate to population centres can present variety of environmental, health and safety risks. While this is likely to be a consideration for problems in countries such as the Netherlands where there are 1,285 inhabitants per square kilometre,[224] it is may not be a consideration in parts of the U.S where the population density is low.

With fracking driving severe boom and bust cycles in local economies, in the U.S, concerns have surfaced about the socio-economic impacts. Although, the arrival of a new well can be beneficial to local economies because of the drilling and related fracking activity, problems can erupt when large numbers of migrant workers move into small communities. This can create a potentially limiting syndrome for local workers in terms of opportunities. The job boom drilling activity disappears very quickly as the well depletes faster than imagined and the workers leave as the economic bubble bursts.[225]

3.4.9 Economic Rivalry for Solar, Wind, and Other Renewables

An understanding of the dynamic of the global energy market and the factors that determine the prices of energy commodities reveals that an increase in the supply of natural gas and oil would result in a decrease in prices. In other words, fracturing diminishes the motivations for the conservation of energy. Aside from the diminishing effect of price, the question is: does shale gas extraction accordingly hamper the smooth development of renewable energy such as geothermal, solar and wind? The answer is open to interpretation by the reader. Arguably from the authors stand point, the answer is in the negative. This is on the premise that shale

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[221]From an investigation published in rolling Stone Magazine, (2012). [Online] Available http://www.rollingstone.com/politics/news/the-big-fracking-bubble-the-scam-behind-the-gasboom-20120301?print=true (Accessed 23/06/2017).

[222]European Gas: A first look at EU shale-gas prospects", October 2011, Deutsche Bank [Online] Available http://www.longfinance.net/images/reports/pdf/db_shale_2011.pdf) [Accessed 23/05/2016].

[223]Geny, F. (2010). "Can unconventional gas be a game changer in European gas markets", T*he Oxford Institute for Energy Studies*, Page 66 [Online] Available http://www.oxfordenergy.org/2010/12/can-unconventional-gas-be-a-game-changer-ineuropean-gas-markets/) [Accessed May 30, 2016].

[224]Terrence, J. C & O' Connell L. K. (2014). Unfinished business in the regulation of shale gas production in the United States, Science of the Total Environment, Volume 476-477, pp.359-367.

[225]"Exposing the oil and gas industry's false jobs promise for shale gas development: How methodological flaws grossly exaggerate jobs projections", November 2011, Food and Water Watch [Online] http://www.foodandwaterwatch.org/reports/exposing-the-oil-and-gas-industrys-falsejobs-promise/ (Accessed 0n 10/05/2017).

gas is not renewable and cannot be compared alongside with other renewables. Government can carve a space through its policy objective and programmes to ensure a percentage of the energy market to renewable energy.[226]

Excluding the protection that can be afforded by such policy initiatives, shale gas is construed as a bridging (or transition) fuel for the international energy mix, which will assist in meeting international energy demands to the point where renewables can compete favourably.[227] In addition, the fact that solar and wind are intermittent sources in themselves, an alternative source of base load energy is needed to fill the gap when they become unable to meet growing demands. Natural gas fits perfectly as the immediate solution when solar energy is not sufficient to supply the entire market.[228]

Nonetheless, there is an inherent risk that lower natural gas price will be a great disincentive for the political support the renewable sector needs and, more specifically, the lower price in natural gas will give a strong competitive advantage so much so that renewables will never become economically viable.[229] Parties against fracturing have not come out expressly to demand for the strengthening of the competitive position of renewables. They have, however, implicitly suggested placing moratoria and stringent new regulatory structures for the governance of fracturing.

If the shale gas and oil industries are the only industries bearing the burden of this tax goal excluding other carbon fuels like coal for example, with all due respect to proponents of such a one-sided decision, it does not make proper sense. The logical platform upon which this dissenting position is opined is that where fracturing is banned or is enormously expensive, whereas coal remains cheap, the effect will not be a dash for more solar and wind energy, instead more coal will be consumed.[230] On a lighter note, such boomeranging outcome is not what environmentalists would be obliged to favour considering the truce that natural gas burns cleaner than coal as sources of energy. Therefore, any bargain to promote a reduction in the consumption of carbon fuels should be discouraged.

The nature of the global climate further reiterates this point. Hypothetically, if the U.S banned fracking activities, would this serve to discourage other countries from using it? The answer is 'yes' because other countries would be willing to follow the trend. The various bans and moratoria is a clear indication of this assertion. There are large deposits of shale oil and gas in China, Argentina, Ukraine, Poland, Libya, and Algeria and in other nations. Although, this might take a considerable period of time for them to develop their ability for shale drilling, in the end they shall carry out commercial development of these resources.[231]

From the above, if this resource has the potential to dissuade the development of renewables, it will make no difference if the U.S alone can forfeit shale gas development. What this single sided effort could do to the economy, is to preclude the U.S from the benefits of fracturing

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[226]See supra Indiana Harbor Belt R.R. Co. V. Am. Cyanamid Co footnote 37, at p.40 (Noting that utilities invest in renewables in part because of state-based renewable portfolio standards).
[227]See supra Coglianese, C *et al.,* (2002) foot note 138 at p.70.
[228]Global Insight HIS, (2012). America's new energy future: The Unconventional Oil and Gas Revolution and the U.S Economy: National Economic Contributions 12 p .16
[229]Tracy, R. (2013). States cooling to renewable energy, *Wall Street. Journal*.
[230]Susan L. B & Meyendorff A, Op-Ed. (2013). The facts on fracking, New York. Times [Online] http://www.nytimes.com/2013/03/14/opinion/global/the-facts-on-fracking.html?pagewanted=all&_r=0 [Accessed March 28, 2016].
[231]Gold, R & Kruk, M. (2012). Global gas push stalls, *Wall Street. Journal*., at A1 (Noting that other nations lag the U.S in technical capacity as well as in knowledge of geological conditions, and that the U.S. property rights system, which vests landowners As opposed to the state with mineral rights, creates added Incentive to drill).

without a corresponding commitment to renewables from a global standpoint. Having discussed the general impacts of hydraulic fracking, it is pertinent to examine a unique risk associated with fracking. This is unique because the rate of occurrence is quite frequent and leaves a transgenerational impact on the victims and the environment. This risk centres on the issue of water contamination.

3.5 Water Contamination as a Unique Risk to HVHF

Ground water is as essential to humans as energy resources. However, the oil and gas industry, using the technique of fracking, has threatened the quality of ground water around shale gas sites. The risk is unique to fracturing in contrast to conventional extraction techniques. In recent times, the risk of hydraulic fracturing as a threat to ground water has attracted significant passion for resistance on both local and international platforms where shale gas development is the subject of discussion in media and environmental forums.

Although there are regulations governing the exploitation of shale oil and natural gas resources in every legal system, since ground water contamination is unique to hydraulic fracturing there is said to be a regulatory vacuum in the area of addressing the issue.[232] It is upon this backdrop that this thesis focuses on designing a regulatory framework to determine how the issue can be dealt with even though discussions are in progress within various legal jurisdictions.

Accordingly, the important challenge for policy makers is the degree to which this fracturing-specific risk is uncertain. In any event, experience on ground presents that the risks are limited; together with the fact that the practice is sufficiently novel, it is difficult to draw a definitive conclusion on the issue. Having said that, this study will proceed to examine the various aspects on how ground water contaminations take place.

3.5.1 Drilling and Fracturing Fluid as First Risk Relating to Water Contamination

No matter what coherent scientific explanation the industry may advance to justify the use of toxic chemicals in fracturing fluids, the truth is that we do not need toxic chemicals to seep through shale formations during drilling and subsequent fracturing into water wells and underground aquifers. However, one wants to look at it, the fact that industry claims that only 5% of the total volume of fracturing fluids are composed of toxic chemicals does not in any way preclude the migration of these toxic chemicals to water wells located near shale oil and gas sites.[233]

Again, in as much as technological advances may reduce the use of toxic chemicals in shale oil and gas drilling, leaks and spills would be completely eradicated if the use of toxic chemicals are excluded from the fracking process. In this regard, it would be completely out of place to assume that it is impossible to exclude toxic chemical use in fracturing because Halliburton has tested a fracturing fluid that uses enzymes and acid from food.[234] A senior Halliburton executive attracted media attention when he was shown drinking the diluted form of the fracturing fluids.[235] Moreover, several other companies are also working hard in

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[232]Wiseman, H. (2009). "Untested waters*:* The rise of hydraulic fracturing in oil and gas production and the need to revisit regulation*"*, *20 Fordham Environmenta Law Review,* 115, 122–23 [Hereinafter Wiseman, *untested waters*] at p.134–35 (discussing fracturing's exemption from the Safe Water Drinking Act).

[233]Bateman, C. (2010). A Colossal Fracking Mess, *Vanity Fair* [Online] http://www.vanityfair.com/business/features/2010/06/fracking-in-pennsylvania-201006. [Accessed March 28 2016].

[234]See supra Ruven, C. F & Leonie, R. (2016) footnote 150.

[235]Hargreaves, S. (2011). Clean fracking: Moving to replace chemicals, CNN Money [Online] http://www.money.cnn.com/2011/11/16/news/economy/clean_fracking/index.htm.

developing "eco-friendly" fracturing fluid.[236] To a large extent others are even hoping to explore options where neither water nor any water substituting liquid propane, carbon dioxide and gas will be used for fracking shale formations.[237] If successful, it will go a long way in addressing the risks associated with the transportation of water to and from shale oil and gas sites. However, in contrast, it may still be necessary to inject the production zone with toxic biocides to prevent the degradation of oil and gas by bacteria in the zone.[238]

Thus, should such scientific and technological advancements tentatively prove positive, they do not provide a complete representation of the much-needed solution in mitigating water contamination risks. The key question therefore is: how will toxic chemicals that are used in fracturing migrate into drinking water wells? The five possible fracturing-fluid risks are described accordingly.

3.5.1.1 Fracturing Fluid Risks: Migration through Subsurface Cracks

One distinguishing characteristic of unconventional reserves and conventional oil and gas reserves is the reduced permeability of these reserves. To produce permeability, existing cracks are either enhanced or more cracks are opened in unconventional oil and gas reserves. This is where the fracturing technique becomes necessary in producing the said cracks in underground shale formations for the easy flow of oil and gas to the surface. The concern with this is that fracturing fluids might follow the opened cracks into water wells and aquifers. This is one of the usually viewed risks in hydraulic fracturing.

According to the proponents of the technique, it is said that the occurrence of this risk is very remote from a geological stand point. This is on the premise that fracturing of shale beds takes place at 5,000 to 10, 000 feet, whereas the water table is typically only 500 to 1,000 feet below the surface.[239] However, multiple layers of rocks and clay, some of which are highly impermeable, are positioned in between the water well and the actual shale formation that is being fractured.

Looking at this argument from a very logical perspective, such an argument does not really hold water. The question the proponents and the industry must answer is as follows: Is there the possibility for migration of the fracturing fluid? If yes, then the argument that there exist highly impermeable rocks in between these shale formations where fracturing takes place becomes simply total guess work to garner cheap support. Fluids, by their very nature, are highly migratory and with time, would certainly find their way to an available water table.

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[236]Carroll, J. (2012). Chesapeake testing 'Green' fracking fluids in shale wells, *Bloomerg News* [Online] Available at http://www.bloomberg.com/ news/2012-10-02/ [Accessed May 23, 2016]; Chesapeake-Testing-Green-Fracking-Fluids-In-U-S-Shale-Wells Html; Press Release, Business Wire, New EPA-Approved Fracking Fluid 100% Green (2012). [Online] *Available* http://www.businesswire.com/news/home/ 20120110005568/en/epa-aproved-fracking-fluid-100-green; Press Release, Family Joule Holdings, Eco-Friendly Fracking Fluid Set For Debut (Dec. 6, 2011), *Available at* http://www.prlog.org/11743014-eco-friendly-fracking-fluid-set-for-debut.html (announcing release of nontoxic fracking fluid made from waste tallow from beef processing by family joule holdings, inc.) [Accessed 23/05/2016].

[237]Bullis, K. (2013). Skipping the water in fracking*, Mit Technical. Review*. [Online] Available http://www.technologyreview.com/news/512656/skipping-the-water-in-fracking; [Accessed 23/05/2018]; Galbraith, K. (2013). Waterless Fracking Makes Headway In Texas, Slowly, NPR [Online] http://Stateimpact.Npr.Org/Texas/2013/03/27/Waterless-Fracking-Makes-Headway-In-Texas-Slowly/. (Accessed March 28, 2017).

[238]Sapien, J. (2009). "With natural gas drilling boom, Pennsylvania faces n onslaught of wastewater*"*, Propublica p. 29 [Online] Available http://www.propublica.org/article/wastewater-from-gasdrilling-boom-may-threaten-monongahela-rive (Accessed 12/12/2017).

[239]Nicot, J. P & Scanlon, B. R. (2012). "Water use for shale-gas production in Texas*", U.S., Environmental. Science. & Technology.* Volume 46, at p.40 Table 2.4.

Other sources share the same view with the above study, but unfortunately believe that if there are instances where fracturing fluids have migrated into water wells and aquifers, there are few documented instances of such migration.[240] The bottom line is that, it can happen. Further, if it was to happen, it would not be possible to recover the quality of the water wells or aquifers to its original state.[241]

To sum up, cracks do take place and fluids do migrate whether downward or upward through cracks/openings, and these activities of oil and gas exploitation take place over a considerable length of time. That in mind, fluids can equally migrate. So, the industry should stop advancing all manner of excuses to evade the responsibility of arriving at a safe and better means of extracting oil and gas resources. Further, individuals cannot adequately predict with all certainty what goes on underground because the geological conclusions are based on simulations which might be correct or incorrect.

3.5.1.2 Surface Spills as a Fracturing Fluid Risk

Surface spills of fracturing fluids are another pathway in which fracturing fluids could migrate to water sources. The realistic nature of these individual risks cannot be over emphasised.[242] Accidents could happen on site and fracturing chemicals may spill on the surface prior to or following the drilling process and might subsequently seep down into the water table around shale gas sites.[243] Accidents can also happen involving trucks that convey toxic chemicals to and from sites. For instance, the chief minerals resource regulator in North Dakota's mineral institution clearly put it this way: "You have got thirty gallons of biohazard at a well site that can be very dangerous in its concentrated form."[244] It is true that the same surface spills can be evident in other industrial and commercial activities that deal with toxic chemicals either by transporting them or storing them in a presumably safe place.

The frequency and typical causes of these spills are still unclear[245] despite reports in the media regarding these spills.[246] This risk of surface spills, however, is not peculiar to fracturing alone. However, it is the issue of water contamination that draws the line of difference in terms of impacts and peculiarity.

There exists variety of regulations already governing surface spills which require spill prevention plans and rules that govern the storage of the toxic chemicals in the U.S. But when we consider the total volume of toxic chemicals that are transported, it can be seen that

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[240]See supra Betts, M. (1991) foot note 88 at p.3-19.
[241]See supra foot note 88.
[242]Fisher, K. (2010). Data confirm safety of well fracturing, A*M. OIL & GAS REP*., p.1-2, [Online]http://www.halliburton.com/public/pe/contents/papers_and_articles/web/a_through_p/aogr%20article%20data%20prove%20safety%20of%20frac.pdf. [Accessed March 29, 15].
[243]National Research Council, the Natinal Academy's., (2012). Induced Seismicity Potential in Energy Technologies 156; Keranen K. M et al., (2013). Potentially induced earthquakes in Oklahoma, USA: Links between wastewater injection and the 2011 Mw 5.7 Earthquake Sequence, 41 Geology 699, 702 (concluding, based on survey of reports of violations of state standards, that the most pressing risks arise not from injection of fracturing fluid underground but from other stages in the well development process and the higher rate of well drilling spurred by fracturing).
[244]Thong, M. (2018). An assessment of the potential for the development of the shale gas industry in countries outside of North America, *Heliyon,* Volume 4, Issue 2, Article e00516.
[245]Ground Water Protection Council on September, (2009) Titled "State Oil and Natural Gas Regulations Designed to Protect Water Resources, US Department Of Energy [Online] Available http://www.fracfocus.org/…/state_oil_gas_agency_groundwater_investigation p.31-32 (Accessed 20/02 2016])
[246]Lustgarten, A. (2009). Frack fluid spill in Dimock contaminates stream, killing fish*, Pro publica*, http://www.propublica.org/article/frack-fluid-spill-in-dimock-contaminates-stream-killing-fish-921. (Accessed 2804/2017).

fracturing now poses a greater measure of surface spill within the entire industry play. The summary of the story is that fracturing fluids ought to be conveyed from one point to the other and stored more carefully since each of these risks presents a more realistic risk.[247]

3.5.1.3 Flow-Back and Produced Water as a Fracturing Fluid Risk

As cracks are produced in the shale formations, the gases that escape through the cracks forcefully push fracturing fluids back up to the surface.[248] Also, water that had accumulated naturally in the shale formation known as produced water is pushed up too.[249] However, this water does not necessarily contain toxic fracturing chemicals but has natural contaminants such as salt, organic compounds, silt, clay, oil grease, and NORMs.[250] So, shale oil and gas operators are expected to capture these fluid when they come up, so they do not seep through to the water table. More often than not, these fluids eventually find their way into water tables before the lifespan of the fracking activity.

One thing this study finds rather disturbing is the claim advanced by the industry that produced water does not contain toxic fracturing chemicals but contains other organic compounds and NORMs. The conclusion is that if the produced water can carry NORMS, what makes toxic fracturing chemicals different, having in mind they are all pushed up to the surface?

3.5.1.4 Through Cracked Well Casings as Fracturing Fluid Risk

Having established the fact that substances underneath could be pushed upward to the surface through cracks produced by fracturing, it is also crucial to note that well casing-layers of steel and concrete encasing the well could crack, allowing fracturing fluids, gas, or oil inside the wellbore to leak out. Due to this eventuality, it is expected that the concrete and steel layers are thick, deep enough and set properly to prevent leaks close to the water table. The effectiveness of well casing in hydraulic fracturing operations is a phenomenon oil and gas regulators are quite familiar with, having in mind it is applicable even for conventional drilling practices. However one wants to look at it, a poorly cemented casing could result in a potential source of leaks irrespective of whether hydraulic fracturing has been done in that well.[251]

3.5.1.5 Blowouts as Fracturing Fluid Risk

Consequently, blowouts can happen inside the well which involves the uncontrollable release of gas and fluid in a gushing manner either to the surface or inside. The major cause of blowouts are due to unexpected pressure differences during drilling phases, well testing, well completion and during production,[252] There are different types of blowouts. Some of these include surface blowouts and underground blowouts.[253] As most hydrocarbons are lighter than rock or water, they tend to migrate upward through adjacent rock layers until either reaching

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[247]See supra Mantell, M. E. (2010) foot note 192.

[248]Entrekin, S. *et al.,* (2010). Rapid expansion of natural gas development poses a threat to surface waters. *Frontiers in Ecology and the Environment,* Volume 9, Issue 9, pp503-511, doi:10 1890/110053.

[249]Rebecca, S. R & Soeder, D. J. (2015). Evolving water management practices in shale oil & gas development. Journal of Unconventional Oil and Gas Resources, Volume 10, pp.18-24

[250]U.S. Geological Survey, Naturally Occurring Radioactive Materials (Norm) In Produced Water and Oil-Field Equipment—An Issue for The Energy Industry, (1999). *[Online] Available* http://www.pubs.usgs.gov/fs/fs-0142-99/fs-0142-99.pdf (finding that produced water can bring to the surface radium that comes from the shale deep underground).

[251]See supra Howarth, R *et al.,* (2011) foot note 210

[252]Westergaard, R. (1987). 'All About Blowout', Norwegian Oil Review ISBN 82-991533-0-1[Online] http://www.en.wikipedia.org/wiki/blowout_(well_drilling)#cite_note-allabout-1 [Accessed 29/04/2015).

[253]Being-Zih, H *et al.,* (2010). Case study of estimating gas loss from a producing well blowout. *Journal of Petroleum Science and Engineering,* Volume 70, Issues 3-4 pp.327-333.

the surface or they become trapped within porous rocks. Further, the process is influenced by underground water flow, which invariably causes the hydrocarbons to migrate hundreds of kilometres horizontally. Having discussed the first risk relating to water contamination in hydraulic fracturing, the fracturing fluid's ability to contaminate ground water as well as the various avenues these fluids can migrate to cause the water risk. This work will now discuss the second risk associated with water contamination.

3.5.2 Contamination of Ground Water Well and Aquifers with Methane as Second Risk.

Methane, as a predominant constituent of natural gas apart from fracturing and produced water, can also be a risk to ground water quality. This risk is more critical than the migration of fracturing fluid as fractured wells have been contaminated by methane as well as conventionally drilled wells according to some reports.[254] The incident of methane contamination is indeed an old situation, and one not peculiar to fracturing alone. As part of an effective response mechanism to address the issue, states should regulate on the thickness and depth of well casings because methane has the ability to leak out through cracks in vertical well pipes that run through aquifers.[255] A typical example is the enactment of legislation in Texas to update its well casing regulation in 2013.[256] Here it is important to note that even old wells that have been in existence prior to fracturing and horizontal drilling can have leakage problems if not sealed properly.

Fracturing might present a possible methane migration from the fractured shale seam through natural fissures in the overlaying rock, or fissures created by the fracturing process into aquifers above or near the seam. Now the understanding that the mere presence of methane in water wells is a product of fracturing is altogether not true.[257]

Moreover, methane can occur naturally and there is the likelihood for shallow methane deposits to migrate up into the water table on its own volition.[258] For example, from 1997 through to 2005, a U.S Geological survey in forty-seven counties in West Virginia conducted prior to the commencement of gas drilling operations found the presence of methane in 131 out of 170 residential wells that were tested.[259] In addition, a study carried out in Pennsylvania in 2011, in an attempt to establish baseline levels of contaminations, showed that methane was found in 40% of wells prior to shale gas drilling.[260] By way of comparison, the study then went ahead to compare levels of contamination after shale gas drilling but found no statistical significant difference.

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[254]Steffen, J & Alberto, J. L. (2013). Shale gas vs. coal: Policy implication from environmental impact comparisons of shale gas, conventional gas, and coal on air, water, and land in the United States. *Energy Policy,* Volume 53 pp.442-453. ("Methane Leakage from Producing Wells into surrounding drinking water wells…Is a greater source of concern [Than leakage of fracturing fluid].").

[255]Ibid at p.41 ("The protection of groundwater aquifers is one of the primary objectives of state regulatory programs, and it should be emphasized that good oil field practice, governed by existing regulations, should provide an adequate level of protection from [methane leaks].").

[256]The Energy Institute, University of Texas, EIUT (2012), Fact Based Regulation for Environmental Protection in Shale Gas Development Summary of Findings. The Energy Institute, University of Texas at Austin, Austin, TX, http://Energy.Utexas.Edu. (Accessed 20/5/2016).

[257]See supra Westergaard, R. (1987) footnote 252.

[258]See supra Russel, C & Powell P. T. (1997) footnote 91 p.20.

[259]Li, Z *et al.,* (2016). Searching for anomalous methane in shallow groundwater near shale gas wells. *Journal of Contaminant Hydrology,* Volume 195, pp.23-24.

[260]Elizabeth, W. B *et al.,* (2011). The Centre for Rural Pennsylvania, the impact of Marcellus gas drilling on rural drinking water supplies Volume 12 *Available at* http://www.rural.palegislature.us/documents/reports/marcellus_and_drinking_water_2011_rev.pdf. (Accessed 6/02/2018).

However, an academic study carried out in 2011 claimed to find the connection between drilling and methane contamination, basing it on the conclusion that there are said to be more methane in Pennsylvania wells that are within a kilometre of ongoing drilling sites than those that are more than a kilometre away from drilling sites.[261]

A close consideration of the above study, however, leads to two developments that question the study's conclusions. First, no baseline testing of the wells was done to establish whether the well had methane prior to drilling. Second, a disturbing factor is that none of the fracturing chemicals used for fracturing was found in the well which ought to be present in the fracturing fluid make up.[262] Be that as it may, the study discussed above, taking its cue from a 2013 study, concluded that a reason why methane can be present in water is principally based on the topography as well as the geological composition of the area in question, than the presence or not of shale gas production.

3.5.3 Sludge and other Residues Disturbance in Wells due to Fracturing

This is the third risk relating to water contamination in hydraulic fracturing. This source of water contamination is triggered by vibrations and pressure pulses from fracturing operations. One very vital aspect of this risk is that the contaminants are already in the well. Fracturing is such that the drill bits moves in a rotary manner and as a result, bring up all iron, manganese and other contaminants from the bottom of the well into the water wells.[263] Logically, this reveals why water wells near drilling sites turns out dirty but might not necessarily include fracturing chemicals in some cases. Resident's water wells living around shale oil and gas wells are often dirtier beyond their realisation, irrespective of shale gas operations. This could arise if rural wells do not have a sanitary-caps or they are situated close to septic tanks that have not been pumped regularly. For instance, a survey carried out in Pennsylvania suggested that only 16% of rural wells have a sealed sanitary well cap, and more than half were near septic tanks that had not been pumped with sufficient regularity.[264] In conclusion, whilst it is possible that fracturing can stir up contaminants already present in water wells, different activities can do so. This can also include running multiple faucets at the same time.[265]

3.5.4 The Injection of Fracturing Waste and Produced Water into Injection Wells and Sewage Facilities.

In some cases, fracturing fluids that have been used by energy companies do not need to be reused. As such, energy companies ought to dispose of it. In addition, produced water which

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[261]Stephen, G. O *et al.,* (2011). Methane contamination of drinking water accompanying gas-well drilling and hydraulic fracturing, 108 PROC. NAT'LACAD. SCI. 8172, 8172 (claiming to "document systemic evidence for methane contamination").

[262]Schon, C. S. (2011). Hydraulic fracturing not responsible for methane migration, proc. of the nat'l acad. sci. *ht*tp://www.pnas.org/content/early/2011/08/25/1107960108.full.pdf (Citing Rob Jackson & Avner Vengosh, *Strong Evidence That Shale Drilling Is Risky*, Philadelphia Inquirer, May 10, 2011, http://www.articles.philly.com/2011-0510/news/29528421_1_water-wells-safe-drinking-natural-gas (last visited on 30/03/2017).

[263]Duncan, I. (2012). Colorado. Oil & Gas Conservation Comm'n, Written Testimony [Online] http://www.cogcc.state.co.us/rr_hf2012/groundwater/presentations/duncantestimony.pdf (positing that "possible perturbation by pressure waves associated with drilling and completion activities that can lead to false positives").

[264]Bryan, R. S *et al.,* (2009). Drinking water quality in rural Pennsylvania and the effect of management practices 9, 11 *Available at* http://www.rural.palegislature.us/drinking_water_quality.pdf (Accessed 01/04/2017).

[265]Eisner, M. (2011). Separating fact from fiction: Careful hydro geologic evaluation may protect against unfair and baseless domestic supply impact allegations, Remarks at the AIPG Marcellus shale: energy development and enhancement by hydraulic fracturing Conference, *Available at* http://www.aipg.org/seminars/hfms/eisner,%20mark.pdf (showing elevated turbidity correlated only with domestic use fluctuations).

is a by-product of all oil and gas production is disposed of too. The efficient and proper disposal of these wastes is very important. However, some disposal methods are risky while others are not.[266]

The land application as a disposal method seem to be the worst form of disposal. This is where fluid is practically poured into the ground. This eventually creates the risk where fluid could seep down into the water table. If this is the case, this method of disposal should be utterly prohibited. Another way in which the fracturing water or produced water could be handled is that it could be relocated by truck to a waste treatment plant for disposal. Here, if the waste treatment facility only dilutes it and discharges it into a body of water, there is certainly going to be a risk of water contamination reason being that the fluid is not going to be diluted to a point where the toxicity is eradicated completely or present in the water body at an accepted limit. This practice was tenable in the past in Pennsylvania.[267]

Conversely, recycling of these fracturing fluids at a more sophisticated treatment process does not pose the same risk mentioned above. It helps to minimise the total volume of waste created. The storage of fracturing fluids and produced water deep underground injection wells is another sophisticated treatment and disposal method.[268]

To further ensure that these disposal injection wells do not constitute a threat to the water table, there is a requirement for energy companies to use well casings which are sufficiently thick enough, and the well itself should be considerably deep enough, so that wastes are situated far below the water table. Some say the risks related to the disposal of hydraulic fracturing wastes and produced water are quite similar with those of injecting carbon dioxide from coal-burning power plants into deep geological fissures.[269]

Accordingly, having discussed what the hydraulic fracturing technique is, and the various available fluid based hydraulic fracturing methods, this has shown that there are better alternatives which could have been taken. Instead, industry chose the slick water based hydraulic fracturing principally due to the fact that it cost less (this will be discussed below). This thesis so far has also been able to show certain general health and environmental issues that slick water hydraulic fracking shares with conventional exploration and exploitation activities as well as the issue of the use of toxic chemicals which raises the high probability rate of water contamination. This Chapter will now address one of the core key questions of the thesis by first reviewing the purpose of regulation and liability as a tool for ensuring safety and reducing risk.

Before analysis what regulation and the role of liability from a law and policy making perspective is, by exploring new innovative options in reducing the attendant risks involved in activities such as shale gas extraction, it is expedient to look at the various forms of fluid based hydraulic fracking techniques.

This exposition is important in that it exposes the motive behind why the slick water hydraulic fracking technique was chosen by industry. To achieve this, the advantages and disadvantages

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[266]Rozell, D. J & Reaven, S. J. (2012). Water pollution risk associated with natural gas extraction from the Marcellus Shale, 32 *Risk Analysis* 1382, 1391.

[267]Schoof, R. (2011). As shale fracturing booms, environmental protection lags, *Mcclatchy Newspaper* http://www.mcclatchydc.com/2011/12/21/133807/as-shale-fracking-booms environmental.html#.uh9qqxtoosp; Olmstead, S. M et al. (2013). *Shale* gas development impacts on surface water quality in Pennsylvania, PROC. *National Academy of Science*. 4962, 4966 (2013).

[268]See supra World Bank, (2000) footnote 89 at p. 43.

[269]Spence, D. B. (2012). 'Federalism, regulatory lags, and the political economy of energy production', 161 U. PA. L. REV. 431, 477.

of each of these forms of fluid based hydraulic fracking will be investigated. The reason for this is to lay the foundation for the justification for stricter regulatory and liability options.

3.6 Forms of Formation Stimulation and their Potential Advantages and Disadvantages

This section will quickly consider some of the various forms of formation stimulation through utilising the hydraulic fracturing technique. Further, the advantages and disadvantages will be investigated with a view to drawing a conclusion as to why water based hydraulic fracturing was chosen above the other forms. Moreover, this section will lay the foundation for Chapter IV which contains the argument for the subjection of the shale gas industry activities to a strict liability regime as well as other policy options meant to address the information asymmetry syndrome which makes regulation and liability as tools for environmental protection lacking in managing the risks associated with fracking. These options were carefully formulated with the overall goal of observing the tenets of precaution.

By way of digression, it is important to say something about the relationship and the difference between the Polluter-Pays Principle (PPP) and the Precautionary Principle (PP). Generally, PPP is a policy tool whereby the polluter or potential polluter is made to internalise the cost of carrying out a polluting activity either to the environment or the health of the immediate community where extractive activities are undertaken. In contrast, the PP espouses the idea that prior to the commencement of any industrial activity which has the possibility of inflicting harm to the environment or to human health, adequate precautions should be put in place. Absence of scientific certainty as to the level of damage is not a preclusion to take precautions.[270]

When one look at both elements, it can be seen that the point is to completely forestall harm where necessary or to reduce the risk to the environment as it affects human health and endangered species, biodiversity and soil.

The various forms of hydraulic fracturing techniques that are in existence within the oil and gas industry have different advantages and disadvantages for operators to decide which one to apply. However, it is necessary to understand the term hydraulic fracturing as it is widely used nowadays to mean the process of fracturing rock formations with water-based fluids.

In applied science and engineering, hydraulic fracturing is a topic which deals with the mechanical properties of liquids, not just water.[271] Apart from hydraulic fracturing, there exist other types of technologies which can be used to extract oil and gas resources from oil bearing rocks. These types may include pneumatic fracturing and fracturing with dynamic loading, to mention a few of them.[272]

Therefore, one can define hydraulic fracturing as the technique which makes use of a liquid fluid to fracture reservoir rocks. With this understanding, the following techniques of hydraulic fracturing shall be discussed: water-based fluids; foam-based fluids; oil-based fluids; acid-based fluids; alcohol-based fluids; emulsion-based fluids; and cryogenic fluids.

It is pertinent to note that the usage of water as a base fluid for hydraulic fracturing is a more recent development.[273] The performance of the first fracture treatments were carried out with

[270]Mead, J. S. (2004). The precautionary principle: A discussion of the principle's meaning and status in an attempt to further define and understand the principle, 8 n.z.j. envtl. l. 137, 141–143 (reviewing the challenges drafters face in the international law context in defining the level of certainty needed to trigger a precautionary approach).
[271]Ketter, A. A *et al.,* (2011). Field study optimizing completion strategies for fracture initiation in Barnett shale horizontal wells. SPE 103232.
[272]See supra Alan, O. S. (2007) footnote 32 at p.40.
[273]Montgomery, C.T & Smith M. B. (2010). 'Hydraulic Fracturing: History of An Enduring Technology',

gelled crude and later with gelled kerosene.[274] Towards the end of 1952, fracturing treatments were performed with refined crude oils.[275] These fluids were inexpensive which permitted greater volumes of production at lower cost. Nevertheless, in 1953, water became popular as a fracturing fluid and a number of gelling agents were developed to be used alongside water as a fracturing fluid.

Consequently, what makes fracking technique a serious issue is its increased frequency levels of certain health and environmental risk and not whether the process of extracting gas is dangerous. The use of water in hydraulic fracking has contributed to one of the increased level of risks associated with shale gas development activities: the large quantity of water being used and lost underground; the need to contain flow backs; the potential contamination of aquifers by leaks of chemicals employed in the fracturing fluids. At this juncture, one point needs to be established which pertains to shale formations. Shale formations are fraught with great variability. This variability has posed a complex phenomenon such that no single hydraulic fracturing technique has universally succeeded in all shale plays.[276] The reason for this is that each shale play has unique properties that are required to be addressed through fracture treatment and fluid design. As such, it is important to provide a brief overview of the various forms of hydraulic fracturing and their merits and demerits.

Nevertheless, one key question that should be asked is: what has motivated the oil and gas industry's interest in choosing the water-based form of hydraulic fracturing technology and not one of the other forms? The answer lies in the usual phrase being used by policy makers each time they want to attract investments whether such venture could have negative impacts on the environment or human health.

This is the "cost effective measure" phrase which has found its way in all forums where the need to arrive at solutions for the protection of the environment and health of citizens comes into conflict with the investor's interest and duty to protect the environment whilst carrying out his legitimate right to do business.

First among the forms to be considered is 'foam-based hydraulic fracturing as a fracturing treatment fluid'. Most of the controversial environmental issues associated with shale gas fracking are attributed to the use of water as a fracturing fluid. The uniqueness of foam as a fracturing fluid is based on its low-density and high viscosity characteristics. In formations that are water sensitive and in places where water is quite a luxury, foams had long been considered as one of the best fracturing fluids.[277]

Foams are also viewed as ideal for fracturing shale gas reservoirs because they require lower, or no water consumption, create less damage in water sensitive formations, and the amount of liquid that returns to the surface is less than what was injected into the ground and can be handled without much logistical stress after the fracturing process. The foam-based fluid has been applied as a displacing agent in porous media and drilling fluids.

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[274]Mistre, M. M. (2018). Shale gas production cost: Historical development and outlook *Energy Strategy Reviews* volume 20 pp.20-25 (discussing about the formation stimulation of hydraulic fracking).

[275]Ibid at p.122.

[276]Lifeng, Q. L *et al.,* (2018). The fractured- controlled Reserves" based stimulation technology for unconventional oil and gas reservoirs. *Petroleum Exploration and Development,* Volume 45, Issue4 pp.770-778*;* Crawford, M. (2013). "Hydraulic fracturing: Mature technology, modern marvel". *American Society of Mechanical Engineers".* [Online] http://www.asme.org/engineering-topics/articles/fossil-power/hydraulic-fracturing-mature-technology-modern-marvel (Accessed 02/12/2017)

[277]Komar, C. A *et al.,* (1979). Practical aspects of foam fracturing in the Devonian shale. SPE annual technical conference and exhibition. Las Vegas, Nevada, not subject to copyright. This document was prepared by government employees or with government funding that places it in the public domain.

In fact, the foam fluid based hydraulic fracturing has proved to be more effective in coalbed fracturing in Canada on dry coalbeds than water-based techniques.[278] In environmentally sensitive regions, there are claims that the use of foam fluid for shale gas operations require less amount of water when compared to the conventional water based hydraulic fracking operations. By this there is little potential health hazards due to chemical additives in fracturing fluids.[279]

Nevertheless, this is not to say that this type of formation stimulation is without some disadvantages. These disadvantages range from low proppant concentration in fluid and difficult characterization of foams. This entails that the flow behaviours are difficult to predict and understand. High cost is involved in using foam-based fluids in fracturing. Also, it requires a higher surface pumping pressure.

The *Oil based fluid hydraulic fracturing* was the first high viscosity fluid deployed for hydraulic fracturing operations. Its compatibility with almost all formation type is what gives it the major advantage as a fluid technique for fracturing. The potential disadvantages hinge on the concern for personnel safety, environmental impact and of course the high cost associated with it. Acid based fluid hydraulic fracturing is another form of formation stimulation technique.

The difference between acid and proppant fracturing is dependent mainly on the way fracture conductivity is created. Whilst propping agents are used to create fractures, acids are used in acid fracturing to 'etch' channels in the rock that comprise the walls of the fracture. For this process to work effectively, the rock must be partially soluble in acid so that channels can be etched in the fracture wells.

At this juncture, from the above-mentioned types of fluid based hydraulic fracturing techniques, two observations can be made. First, it can be concluded that it is possible to overcome the shortcomings and challenges associated with the other forms of fluids used for hydraulic fracturing, if adequate attention is channelled toward more research and development with a view to finding scientific solutions by the industry.[280]

However, one disadvantage that kept on recurring in other forms of fluid-based fracturing apart from water based hydraulic fracturing is the actual high cost involved in their application. Therefore, rather than governments rushing for technologies that have grave impact on health and the environment, policy makers and regulators should adopt a precautionary approach that gives preference to expensive technologies which are environmentally friendly and decent to the human health than encourage cost effective technologies with grave health and environmental consequences.

Until this is addressed in the policy making process, the essence of the precautionary principle will be defeated. Surprisingly, we see a sharp contrast to the true tenets of the principles in that the term 'cost effective measures' could be adopted to promote sustainable means of development. What this cost-effective measure has done is to promote and encourage economic actors of potential and polluting activities to come up with the cheapest forms of technologies to achieve the demands of extraction for economic goals.

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[278]Gupta, S. (2003). Field application of unconventional foam technology: extension of liquid co_2 technology. SPE annual technical conference and Exhibition. Denver, Colorado, Society of Petroleum Engineers.

[279]Edrisi, A. R & Kam S. I. (2012). A new foam rheology model for shale-gas foam fracturing applications. SPE Canadian unconventional resources Conference. Calgary, Alberta, Canada, Society of Petroleum Engineers.

[280]See supra Global Insight HIS. (2009) foot note 160 at p 63-64.

From the point of view of this author, the PP should be redefined to a point where precautionary measures should be adopted prior to the commencement of an industrial activity which has the potential to impact the environment and health of humans. By this, we mean technologies that are costly but are environmentally sound should be given priority over technologies which are cheap to operate but not environmentally sound. The foam based hydraulic fracking technique is a ready example in this direction.[281] Where this is not possible a stricter liability regime should govern the attendant risks that emanate from such activity. This is where the strict liability principle takes credence to forestall the challenges associated with the slick water hydraulic fracking as a relatively new technology.[282]

It is also pertinent to analyse the U.S legal regimes applicable to shale gas extraction, to understand the dynamics and the gaps inherent in the legal framework in order to justify the proposition for the policy intervention options for which the thesis seek to identify for mitigating risks associated with the development of shale gas.

3.7 Summary

Although there is still difficulty in determining the actual degree of risk to people and the environment, the health hazards associated with shale gas fracking are substantial. Multiple factors are responsible for the degree of risk and threat to health and environment associated with unconventional gas development through fracking. A comprehensive health impact assessment must mandatorily take into cognisance the different possible effects and pathways and assess the additive and compound effect of multiple risks. The health impact assessment must be tailored along the lines of the geological, economic, environmental and social characteristics of each surrounding shale play.

A high level of unpredictability is caused due to the uncertainty created by the multiplicity of factors involved in shale gas extraction activities. For example, a study from North eastern Colorado found that air pollutant emissions associated with shale gas extraction increased after tighter emission standards had been implemented, contrary to what would have been expected, and indicating that regulations cannot be guaranteed to reduce risks.[283] Therefore, there is no clear confidence regarding the system's robustness and protection toward human and ecological health.

Fracking is also a disruptive and intrusive activity that will damage the natural environment, create noise and light pollution, and impose variety of social and economic stressors onto surrounding communities. While most of the experiences and evidence of the impacts of fracking has been generated from the US and other countries, the risks associated with fracking could be severe in UK due to geological factors, the density and size of surrounding populations and the proximity of agricultural and tourist activity.[284]

It is also pertinent to note that in countries where shale gas development intends to commence, like the UK, a growing body of literature shows that fracking cannot be carried out with

[281]See supra Mead, J. S. (2004) foot note 270.
[282]Morton, M. Q. (2013). "Unlocking the earth-a short history of hydraulic fracturing" Vol 10, No 6 GEO Expro Magazine on North West Europe and new technologies [Online] http://www.geoexpro.com/magazine/vol-10-no-6 (Accessed 25/03/2017).
[283]Thompson, C *et al.,* (2014). Influence of oil and gas emissions on ambient atmospheric non-methane hydrocarbons in residential areas of Northeastern Colorado. *Elementa.* 2, 000035.
[284]Hays, J & Shonkoff, S. (2015). Toward an understanding of the environmental and public health impacts of shale gas development: An analysis of the peer-reviewed scientific literature, 2009-2014. Available At: http://www.psehealthyenergy.org/data/database_ analysis_2015.1_.27_1.pdf.

complete safety via any regulatory framework in regions that are densely populated.[285] From the analysis of the impacts of shale gas fracking, some of the risks associated with shale gas can be minimised and some cannot. However, the key question is whether the risks associated with shale gas fracking can be curtailed to an acceptable limit. For now, the regulatory systems for fracking in most legal frameworks is not clear, complete and robust enough to accommodate this evolving change.

It is also the finding of this work that, considering the health and environmental risks involved in fracking, most countries have concluded that the risks and harms associated with fracking outweigh the potential benefits. To this effect, an outright ban of the process is evident in some countries.[286] Based on the foregoing risks and harms associated with shale gas fracking, this study therefore calls for at least a three moratorium on all activities related to fracking as part of a precautionary approach to:

(a) Learn from research that will be published in due course;

(b) Argue and manage the uncertainties surrounding in the current regulatory system as well as deal with the problems of the inevitability of risks occurring; and

(c) Carry out a holistic health impact assessment that incorporates all potential risks to health, including their cumulative and compound effects on each other for them to be directed toward the specific geological, economic, environmental and social characteristics of the areas targeted for fracking.

Furthermore, the development of unconventional shale gas is likely to displace renewable and low carbon sources of energy rather than displacing dirty coal. Invariably an economic environment that is inappropriate and non-conducive toward renewable energy development is created because of the current abundance of relatively low-cost natural gas, coupled with heavy subsidies and a lax regulatory environment for fossil fuels in the U.S and other parts of the world.

The way forward is for industry to begin balancing commercial interests with environmental and social economic responsibilities such that the industry is willing and should be incentivised to engage in technologies that are more sustainable before introducing them to the market. Operators of shale gas sites should endeavour to integrate environmental and social justice into their performance. They should definitely arise above commercial interests to deliver and carry out their operations in a sustainable way. Engagement in continuous intellectual dialogue and interactions aimed at finding answers and solutions to the risks associated with shale gas should be strengthened in the field of energy law and policy.

[285]Schwede, K. (2012). Shale gas interest representation in the EU: Public affairs/lobbying in the European Union, Master's Thesis. Norderstedt, Germany Grin Publish & Find Knowledge, p.10.
[286]Wiseman, H. (2013). "Risk and Response in Fracturing Policy," University of Colorado Law Review 84 [Online] http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2017104. [Accessed 26/07/2018].

Chapter 4

4. Regulatory Design: A Review of Regulation and Its Alternatives in Risk Mitigation

The utility of deterring environmental and health harm from potential violators engaging in risky activities has been dependent on regulation in recent times. The principle of regulation to achieve compliance to safety standards is gradually losing its relevance for effectiveness in risk governance. This is partly because these risks producing technologies accordingly are highly dynamic and complex to understand even by the inventors and regulatory institutions.

To this end, there is need for flexible, innovative legal and regulatory approaches that present great value as they hold potential violators accountable at every level for their actions. Another ramification is that they redefine the concept of compliance because compliance reflects effectiveness in regulation. Regulatory agencies will not only assess effectiveness based on the willingness of potential violators to adhere to prescriptive regulatory standards, rather the ability of potential violators to anticipate the likelihood of harm and act though that measure is not included in the initial prescriptive regulation.

This prescriptive regulation creates a huge problem for effective risk mitigation. Where potential defaulters of environmental standards know that they are shielded from eventual liability having applied and followed these requirements, it encourages technology inventors and product manufacturers to settle for the most cost-effective option where alternatives exists. From observation, and as this thesis has examined in detail in section 3.6, other alternatives of extraction are more eco-friendly. However, industry is instinctively inclined to act in a way to avoid extra cost. Hence, the cheapest option is preferred among the list of fluid based hydraulic fracking techniques.

It is based on these assumptions, that this Chapter examine the properties of the alternatives to traditional regulation such as self-regulation and liability regimes. These alternatives to regulation have an in-built mechanism to compel operators of risky activity to mitigate risks to a socially optimal level. To achieve this, this thesis will first review the principles of regulatory design to clarify the rationale behind making regulation for industry. . Having done that, it will give a comparative overview of the various alternatives to regulation. To this end, the potential benefits and criticism of each of them will be analysed. So, the reader sees why these alternatives fits well in mitigating the contentious risks associated with fracking such as water contamination.

4.1 Introduction

There has been an evolving phenomenon in the field of environmental regulation since its establishment in the 1960s.[287] When the earliest generation problems were first addressed, new obstacles were presented which revealed the limits of traditional safety environmental systems to tackle these new problems. As part of the way forward in arriving at a sustainable solution in tackling these challenges, institutions saddled with the responsibility of regulation proposed guidelines for reforming environmental regulation and liability. Despite the divergence in each of their points of view, they are still without some very strong convergence in terms of the recommendations they present. This section aims to establish a detailed list of principles for environmental liability from the contributions made by several scholars with a view to ensure effectiveness in environmental regulation. It is important to mention upfront that for any environmental regulation to become effective in mitigating the risks associated with energy extraction, they must include the following: strict liability issues; participatory;

[287]Ribeiro, F. M *et al.,* (2015). Principles of environmental regulatory quality: a synthesis from literature review. *Journal of Cleaner Production,* Volume 96, pp.58-76.

decentralised; adaptive to change; rigorous on enforcement; induce innovation; multi-instrumental; performance-based; planned and gradual; measured and communicated; ability to strike a balance between conflicting interests; induce self-regulatory approaches; and be reflexive.

Having said that, it is important to discuss the concept of regulation and liability as systems for tackling and managing risks associated with shale gas extractive activity to see how it helps address fracking risks. The reason for this is that these two systems forms the basis for the bulk of the arguments for the effective management of the risks associated with extracting for oil and gas through hydraulic fracking.

In this regard a definition of each of these systems shall be attempted; their characteristics, the roles and the factors that inhibit the proper application of the system towards its desired designed objective in managing risks from industrial activities like fracking, the benefits and cost of liability regimes, certain alternatives to regulation, the limits of safety regulation and the need for liability to fill the vacuum and the justification for regulation.

The idea of regulation and liability in tort as it were with regard to safety terms represents two different approaches for managing activities that creates risks of harm to others.[288] The principle of liability under tort is private in nature and does not function at the whims and caprices of the state but rather it works indirectly through the consciousness in the minds of operators that once their actions results in harm, liability is therefore provoked too. It has this in-built deterrent effect of damage code.[289] On the reverse side, prohibitions, standards and other safety regulations are public in nature and change the conduct and behaviour directly through the imposition of certain obligations and requirements, at least independently of, and prior to, the actual occurrence of harm.

Thus, as a matter of simple description, it goes without saying that the nature of the activity to be governed considerably determines the variableness in terms of the emphasis to be employed between liability and safety regulation. For example, whether someone is running to catch a bus and eventually collides with another road user will be influenced more by the possibility of their tort liability than by any prior regulation of their behaviour.

In the same vein, whether my neighbour's roof is damaged because of a tree I cut down is affected more by a prospect of a tort suit than by direct regulation. However, other decisions may be determined substantially, although not entirely, by safety regulation. For instance, where a truck owner drives through a tunnel when it is loaded with explosives or a situation where a store owner marks the fire extinguisher, or whether an electricity company includes certain safety features in its nuclear power plant.

The effective regulation of shale gas must provide enough protection to human health and the environment and must improve upon what has been developed in the past. Looking at the regulatory arrangements surrounding shale gas development, it is glaring that they are accomplished within a solid framework of laws and regulations that have been developed over many decades for conventional oil and gas.[290] The USA is a typical example of this scenario and in some regions as will be illustrated in the subsequent Chapter.

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[288]Shavell, S. (1984). "Liability for Harm versus Regulation of Safety." *The Journal of Legal Studies* 13, No.2, 357-374 [Online]www.http:doi.org/10.108/467745 (Accessed 20/02/2017).

[289]See supra International Energy Agency. (2012) foot note 200.

[290]Kolb, W.R. (2014). The Natural Gas Revolution: The Pivotal of the World's Energy Future, Pearson Upper Saddle Rivers, New Jersey, United States of America p.45-47

Despite the fact that these regulatory structures were put in place prior to the advent of major shale gas production, they are still applicable. Taking a cue from the experiences of shale gas development in the U.S where the principal regulatory authority lies with the states, compliance with regulatory requirements for shale gas development is being accomplished in many states through additions to and modifications of existing regulations. Hence, the significance of this work is to develop certain policy options in conjunction with the existing conventional oil and gas legal frameworks that regulate the shale gas industry for reducing the inherent risks associated with gas fracking.

4.2 Definition of Regulation Attempted

Regulation can be defined as obligations imposed by public law designed to induce individuals and firms' outcomes which they would not voluntarily reach but are in the public interest.[291] Regulation is enforced by public officials and compliance is aided by the threat or imposition of certain sanctions.[292] Generally speaking, regulation is a principle or rule (with or without the coercive power of law) employed in controlling, directing, or managing an activity, organisation, or system. From a law perspective, it is a rule based on and meant to carry out a specific piece of legislation (such as protection of the environment).[293] Regulations are therefore enforced usually by a regulatory agency formed or mandated to carry out the purpose of promotion of a legislation. This is also called a regulatory requirement.[294]

4.3 Principles of Regulatory Design

At this juncture, it is necessary to identify the core principles underpinning regulatory design. This is not in any way purporting to prescribe specific solutions to environmental threats. Rather they provide the guidelines and road map that will equip policymakers to arrive at those solutions. These principles shall be discussed sequentially below.

To achieve this, the Chapter will first begin by arguing the usefulness of using combinations of instruments which is meant to conserve resources and avoiding unnecessary proliferations of such combinations. Second, the work states that in choosing those combinations, there are compelling reasons of efficiency, effectiveness, and political acceptability for preferring the least-interventionist combinations that will work. Third, this study recognised that whether a particular measure for risk mitigation will work or not is not always apparent in the abstract rather an inclusive escalating response up an instrument pyramid in order to achieve more responsive regulation and to achieve greater dependability of outcomes. Fourth, this thesis argues that to effectively redeploy government's resources in areas where they are better used, it is suggested that a broader array of parties should be involved (most notably business and commercial and non-commercial third parties) who will act as surrogate regulators within specific industries like the shale gas sector. Finally, a redesign of the regulatory and liability systems as mechanisms for environmental and health protective tools is demonstrated to achieve a win-win outcome and broaden the range in which such outcomes are achievable.

Hence, the most relevant principles analysed in this thesis in this section that shapes regulatory design in improving compliance should be centred around principles that support policy regulatory mix strategy (self-regulation and C&C regulation) and those principle that are built around a pyramid schematic representation escalating up an instrument to the extent necessary

[291]Marsden, E. (2014). Risk regulation, liability and insurance: literature review of their influence on safety management, F*oundation for an Industrial Safety Culture.*p.5 [Online] www.foncsi.org (Accessed 20/07/2017).
[292]Ibid.
[293]Alvin, A. L. (1992). A need for new approaches: Command and control no longer a cure-All. *EPA Journal*.
[294]Mostert, E. (2015). Who should do what in environmental management? Twelve principles for allocating responsibilities. *Environmental Science & Policy,* Volume 45. pp123-131.

to achieve policy goals (i.e. deploying less drastic means of achieving compliance first before imposing a more drastic means of regulatory strategy for controlling irrational firms behaviour that leads to recurring risks from an activity. These two principles are assumed to be most important and will prove most successful in the regulation of risks in the field of energy law and policy in that it underscores the complementary interdependence of co-operative and punitive regulation in accomplishing compliance for mitigating risks from resource extraction activity.[295] Also, these principles are most effective and important in regulatory design in that it prevents the possibility for regulatory failure in achieving its outcomes. Regulatory failure could arise from the inability of states regulation to interact with pre-existing "indigenous" normative orderings in the target population including management systems and organizational cultures, etc.[296] These principles (1&3) further reveals that a good understanding of compliance and regulation entails not just an understanding of regulator's strategy, but involves the understanding of "regulatory space" in which traditional regulation operates.[297]

Shearing's explanation of the understanding of regulatory space is worth quoting for a good understanding of what this means in regulatory design. He explains:

> *One way of thinking of about this is to imagine regulation as taking place in a space in which different regulatory schemes operate simultaneously. The occupants of this space may change but it is never empty. If one set of regulatory influences diminishes this simply changes the relationship between occupants of this space…regulatory space is a terrain in which the state must compete for control of regulation with other regulatory entities.*[298]

Thus, regulatory pluralism and regulatory instrument mixes in regulatory design principles value to energy law and policy parlance was summarized by Rees when he explains that pluralism is a perspective that sees:

> *The forms and courses of regulatory ordering… not just as unitary and state-centred, but as diverse and multi-centred. Just as health care is not found primarily in government agencies; rather, it is to be found in the normative systems indigenous to a variety of institutional settings…-universities, union's facilities, hospitals, business corporations, and many other corporate groups. Like the state, these indigenous regulatory systems also have the capacity to make rules and induce compliance amongst group member.*[299]

Having articulated the most important regulatory design principle that contributes to the effectiveness of regulation, it is important to analyse each principle to have a definite and broad understanding of each principle. They include the following:

4.3.1 Principle 1. Prefer Policy Mixes Incorporating Instrument and Institutional Combinations.

It has been argued by Gunningham and Grabosky that there are very few instances where a single regulatory instrument and option have likely resulted in efficient or effective means of

[295]Burby, R. & Paterson, R. (1993). "Improving compliance with state environmental regulation" *Journal of Policy Analysis and Management*, Volume 12 pp. 753-772.
[296]Scott, C. (1998). Analysing regulatory space: Implications for institutional design and reform" Law & Society Association Annual Conference, Aspen, Colorado.
[297]Ibid
[298]Shearing, C. (1993) "A constitutive conception of regulation" in Grabosky, P. & Braithwaite, J. (ed) *Business Regulation and Australia's Future,* Australia Institute of Criminology, Camberra .pp.72-73
[299]Rees, J. (1988). Reforming the Workplace: A study of Self-regulation in Occupational Safety, University of Pennsylvania Press, and Philadaephia.

addressing a particular environmental problem.[300] For example, a ban on the manufacturing of certain highly toxic substances is a ready instance where a single regulatory instrument may be a highly effective means of preventing their use, without the requirement of invoking additional instruments.[301] Nevertheless, single regulatory instruments have both strengths and weaknesses and none are successfully flexible and resilient to be able to adequately address all environmental problems in most cases.[302]

The dependability and predictability characteristic which the command and control regulation has if adequately enforced can never be over emphasised, but the downside of being inflexible and inefficient cannot equally be jettisoned.[303] Conversely, economic regulatory instruments tend to be efficient but lack the virtue of dependability in most cases. Although information-based strategies and self-regulation have low reliability when used in isolation, they tend to be non-coercive, un-intrusive and cost effective. However, the success of the two strategies depends heavily on the extent of the gap between members of the public and private interests.[304]

Thus, the best means of taking advantage of the strengths of single instruments and overcoming their deficiencies is through the design of combination of instruments such as 'regulation' and 'liability' systems. The norm in most jurisdictions is that regulatory responsibility and processes has been artificially confined within the purview of government and industry. This further exemplifies the outmoded problem of government as an exclusive source of regulatory authority. Hence, there is the need for a wider range of innovative options which have the indirect effect of compelling actors ranging from commercial third parties, such as banks, insurers, consumers, suppliers, and environmental consultants, and non-commercial third parties to assist in taking such a huge role off the hands of government. This automatically gives government the leverage to redirect its limited resources to genuinely stubborn companies and become the chief facilitator and broker of third party participation in the entire regulatory process. In addition, the idea of multi regulatory parties involved makes the entire regulatory process to be mutually strengthened because they serve as check to one another.

The challenge of using combinations of instruments and participants as a regulatory approach is that it lays a foundation whereby all conceivable policy combinations will be put in one policy design on the bases that the severity of the environmental problems we seek to address and their likely impacts on humankind are such that they require virtually any level of resource input.[305] This approach however is likely to be suboptimal for a variety of reasons.

First, the capacity of industry to comply with a large range of regulatory and quasi-regulatory requirements will be limited due to regulatory overload which is now a well-recognised phenomenon.[306] Second, it automatically means that the responsibility to cater for the running of this type of combination of instrument is imposed on the public purse as well as putting excessive demands on public resources. Third, some instruments and institutions will not

[300]Gunningham, N & Grabosky, P. (1998). Smart regulation: Designing environmental polic*y.* Oxford: Oxford University Press.
[301]See supra Smith, K. (1996) foot note 72.
[302]See supra Gunningham N & Grabosky P., (1998) Chap.2 footnote 300.
[303]Reese, G & Jacob, L. (2015). Principles of environmental justice and pre-environmental action: A two-steps process model of moral anger and responsibility to act. *Environmental Science & Policy*. Volume 51, pp.88-94.
[304]Gunningham, N; & Young, M. D. (1997). Toward optimal environmental policy; the case of biodiversity conservation*. Ecology Law Quarterly 24; 243-98.*
[305]Robert, H. W. (1993). Towards a new environmental paradigm. *Yale Law Journal* 102:1719-61.
[306]Osborne, D. E & Gaebler, T. (1992). Reinventing government. Reading, Mass.: *Addison Wesley.*

serve the complementary aim envisaged here because some combinations are either inherently made to soothe a particular risk from an activity.

As a result, they end up being counterproductive, duplicative, or suboptimal. These negative effects could be because of poor design at the policy level or through political misfortunes.[307] Braithwaite provided an example of the latter: "[Suppose] there are two coherent policy packages on offer: ABCD and WXYZ. One constituency lobbies for the first because it likes features A and B of this package. Another constituency lobbies for the second because it likes Y and Z. The politicians then try to give everyone what they want by opting for a policy package ABYZ. Unlike the original two policy packages, ABYZ turns out to be totally incoherent. For example, A and Z are mutually contradictory: the purpose of A is defeated when it is put together with Z.[308]

On the premise of these pitfalls, it is imperative to establish innovative approaches that will foster the design of combinations that are complementary. The following innovative approaches on how to reduce the risks associated with shale gas fracking will be examined in some detail by way of enabling a complementary mix of policy instruments, where necessary to escalate up to higher levels of coerciveness and intrusiveness, and to foster for a design for certainty while maximising the potential for economically beneficial outcomes in the regulatory process. The complexities involved in designing such an all-inclusive regulatory process are so challenging that very little attention has been given in the policy and regulatory literature.

4.3.2 Principle 2. Prefer Less-Interventionist Measures

Prior to any discussion here, it is crucial to define the term intervention that comprises of two principal components: prescription and coercion. While prescription refers to the threshold and manner to which external parties such as regulatory bodies and civil society groups dictate the level, type and method of environmental improvement and quality,[309] coercion, in contrast, refers to the threshold to which external parties or instruments determines a firm's improvements and its performance by placing negative pressure on it.[310] Some have argued for instance that self-regulation is higher in terms of its prescriptiveness than its coercion.[311] That is to say, under the prescriptive style of intervention, it may be required for firms to address specific issues and adopt certain behaviours, as contained in codes of practice.[312]

However, the corresponding external enforcement mechanism is designed to ensure that their obligations as firms are observed. In contrast, economic instruments such as taxes and charges are low on prescription and high on coercion.[313] What this actually means is that by and large firms cannot avoid the exigencies that comes with the price signal through which coercion is exercised. The firm's decision on how to react to the price signal is outside the purview of

[307]Braithwaite, J. (1993). Responsive Regulation in Australia. In *Business Regulation and Australia's Future, (*ed.) Grabosky P & Braithwaite J. Canberra: Australian Institute of Criminology.
[308]Aven, T; & Renn, O. (2018). Improving governmental policy on risk: Eight key principles. *Reliability Engineering & System Safety*, Volume 176 pp.230-241.
[309]Timothy S., (1995). Review of economic incentives and environmental policies: Principles and practice*,* (ed.) Opschoor J. B & Turner R. K. *Review of European Community and Environmental Law* Volume 4, Issue 1, p.85.
[310]Eugene B; & Kagan, R. (1982). Going by the Book: The Problem of Regulatory Unreasonableness*.* Philadelphia: Temple University Press.
[311]David, V. (1986). National Styles of Regulation*:* Environmental policy in Great Britain and the United States. Ithaca, N.Y.: Cornell University Press.
[312]Ian, A & Braithwaite, J. (1992). *Responsive* Regulation. Oxford: Oxford University Press
[313]Martin, B; & James, P. (1997). Environment-Related Management Accounting: Current Practice and Future Trends. *Greener Management International* 17:32-52.

external influence.[314] Accordingly, they may opt to pay higher taxes or change their conduct so as to limit the impacts they pose to health and the environment. If they choose the former, then they have no control over the type of remediation implemented. Thus, to rank the categories of instrument according to the level of intervention is based on balancing or assessing each of the constituent components that prescription and coercion presents.[315]

From a general consideration, it has been agreed by scholars[316] that where all other things are equal, there are variety of factors why less interventionist approaches should be given credence to more interventionist ones. Most of these reasons can be understood from the evaluation criteria which range from: the unique characteristics of the environmental problems being addressed; the range of potential regulatory participants and policy instruments; the opportunities for consultation and public participation and the desired policy goal(s); and the trade-offs necessary to achieve it.

It is on these premises that this thesis takes a cue to embark on designing a framework that is geared toward a less interventionist approaches through developing an innovative self-regulatory system to further govern shale gas development operations. In particular, the issues of efficiency, effectiveness, and political acceptability are some of the reasons why highly interventionist approaches are rated badly. In efficiency terms, highly coercive instruments most of the time require huge administrative resources in terms of policing and monitoring, of which without them they might be inefficient.

Moreover, instruments that are highly prescriptive lack flexibility and do not encourage cost solutions. Most traditional C&C options possess both prescriptive and coercive characteristics which often account for the criticisms this approach face. As a result, there is the temptation to unnecessarily deploy resources for highly interventionist strategies to police those operators who ordinarily would be quite willing to voluntarily comply under less-interventionist options.

On the one hand, sometimes the irony is that enterprises being regulated are forced to spend substantial amounts of money in order to satisfy highly prescriptive environmental and health requirements that do not actually present the least-cost effective option to the environmental problem in question. On the other hand, enterprises that uphold good environmental standards may eventually suffer under highly interventionist approaches which often result in hindering them from going beyond the compliance requirements as prescribed by regulatory agencies. Given these evaluations, highly interventionist approaches are generally less efficient and effective than viable innovative policy alternatives. [317]Just like conscripts generally respond less favourably than volunteers, high interventionist options are also unlikely to be an effective alternative policy option in resolving the risks of harms associated with energy resource extraction.[318]

Regulated enterprises are responsive to positive economic incentives like tax credits and subsidies than to negative measures such as taxes and charges imposed. Therefore, high coercive approaches can be counterproductive in that they may create resentment and resistance from those who view them as unjust and an intrusive intervention by nature, than

[314]See supra Robeiro F. M (2013) footnote 287 p.4.
[315]Grabosky, N. P. (1994). Green markets: Environmental regulation by the private sector. *Law and Policy* 16 (4): 419-48.
[316]Santos, R *et al.,* (2006). Stakeholder participation in the design of environmental policy mixes, *Ecol. Econ.* Volume 60, Issue 1, p. 100-110.
[317]Ibid.
[318]Sakar, R. (2008). Public policy and corporate environmental behaviour: A broader view. *Corporate Social responsibility Environmental Management, Volume 15, Issue 5, pp.281-297.*

the practical resolution of environmental problems. In addition, the response of the relevant regulatory agency determines the success of the C&C interventionist approach.[319]

For example, American enforcement agencies characterised by adversarial legalism may spawn a culture of regulatory resistance among regulated enterprises.[320] The culture of regulatory resistance will most definitely result in the consumption of enormous resources for both regulator and the enterprises being regulated in wholly unproductive administrative and legal challenges.[321] It is not surprising that high intervention is also criticised negatively in terms of political acceptability.

This is often the case in the energy sector, with a proven historical independence from, and a strong resentment of, government regulatory intervention.[322] For example, taxes and clearing controls can produce considerable resistance in the oil and gas sector, and this makes it extremely difficult to monitor and enforce direct regulation considering the lack of information asymmetry that exists in the operation of extracting these resources. This, makes it impossible for regulators to determine the conduct of operators therein.[323] Also, due to the powerful lobbying strategies of oil and gas companies, highly interventionist approaches have been avoided by policymakers. However, quite recently they have preferred the provision of information and persuasion in place of direct regulation.

Conversely, low interventionist approaches provide greater flexibility to enterprises and their response, greater ownership of solutions that they are directly involved in creating, less resistance, greater legitimacy, greater speed of decision making, sensitivity to market circumstances, and lower costs than the problems associated with a highly interventionist approach as described above.[324]

To this end, Muir argued in his book titled '*Under What Circumstances Can Law Bring about Attitude Change'* that there is enough evidence to show that policy combinations that are non-coercive are more likely to produce both compliance and a positive attitude change.[325]

Therefore, the underlying implication in this principle of "commencing with the least interventionist policy approach" [326]should be the presumption that the approach is going to work. In other words, the instrument is equipped to deliver the identified environmental and health outcomes from the relevant resource extraction activity. For example, tradeable permits are likely to be effective only when they can be readily monitored and verified and there is good trading prospect.

[319]Robert, K. (1994). Regulatory Enforcement. In Handbook of regulation and administrative law*,* (ed.) D. Rosenbloom and R. Schwartz. New York. Dekker.
[320]Ibid.
[321]See supra Marsden, E. (2014) foot note 291.
[322]Yap, N. *et al.,* (2007). Corporate environmental innovation and public policy. Case studies from Taiwan. In: Parto, S & Herbert-Copley, B. (eds.) Industrial Innovation & environmental regulation, United Nations Press, New York, pp.22-50.
[323]See supra William K J. (1992) footnote 30.
[324]Sigler, J A & Murphy; J. E. (1989). Interactive corporate compliance: An Alternative to Regulatory Compulsion*.* New York: Quorom Books.
[325]Muir, W. K. (1967). Under what circumstances can law bring about attitude change? In: *Law* and *Change* in modern America, Ed. J. B. Grossman and M. H. Grossman. Pacific Palisades, Calif.: Goodyear Publishing.
[326]See supra Indiana Harbor Belt R.R. Co. V. Am. Cyanamid Co foot note 37 at p.45.

4.3.3 Principle 3: Escalate Up an Instrument Pyramid to the Extent Necessary to Achieve Policy Goals.

The previous principle proposed the idea that a least interventionist approach that will seem to work should be given preference. The mystery in the equation is that policy designers apparently do not know whether a particular approach they choose will work or not, for two principal reasons. First, given the different behaviours of regulated enterprises, an instrument may be effective in influencing the conduct of some behaviours but not for all. This dynamic exemplifies the need for regulation to be responsive to the mix of regulated companies and their behaviours. Second, a seemingly likely viable instrument may prove not to be so viable through practical experience thereby creating the urgency for deploying stricter regulatory measures to increase dependability. Given these concerns, the strategies needed to address them should invoke a far-reaching mix of instruments and harnesses a wider range of parties in the regulatory process.

To address the first problem, John Braithwaite provided a window of opportunity in building regulatory responsiveness in his enforcement pyramid where he conceived of responsive regulation crucially where regulation promoted the culture of dialogue in which regulators express to industry their commitment to escalate their enforcement response whenever lesser levels of intervention do not achieve its intended objective.[327]

Under the model proposed by Braithwaite, regulators respond by offering cooperation as a way of showing virtue. The virtue assumed by regulators changes with progressively punitive and deterrent-oriented strategies against the regulated enterprises when their expectations are not met until the regulated enterprise comply accordingly.[328] Such progressive punitive response measure can commence by persuasion or issuance of warning letters as the next stage. Where that does not get the regulated firm to conform, administrative notice is issued too. Where that seems not to work, civil penalties could be invoked against them. This can be followed with a criminal penalty. Regulators can use license suspension as a more severe measure where the former fails. Where the suspension is defeated, the final punitive measure which is license revocation can be deployed.

The need for gradual escalation up the face of the pyramid and the existence of a credible peak or tip, which, if activated, will be sufficiently powerful to deter even the most egregious defaulters. These are the two considerations that are central to Braithwaite's model. The former is a laudable mechanism by which regulators can build responsiveness (rather than any abrupt shift from low to high interventionism) because it resonates the 'tit for tat' response as part of the regulation.

Under this strategy, the regulatory agency deals with each oil and gas company in a cooperative, flexible manner but turns to punishment when the company clearly defects from cooperation. Once the firm begins to cooperate again, the agency does so too. Nevertheless, the latter is crucial in that it has this deterrent value, but it actually ensures a level playing field because the virtuous companies are compensated and not disadvantaged.

A critical look into the dynamics of the energy industry like the shale gas extractive sector, there is every possibility to reconceptualise and go beyond the Braithwaite's pyramid in two important considerations. First, the pyramid model is interested in the behaviour of, and interaction between, two parties: (state regulator and business) regulated enterprise when there

[327]Eberl, J & Jus, D. (2012). The year of the cat: Taxing nuclear risk with the help of capital markets. *Energy Policy* Volume 51 pp.364-373.
[328]See supra Sakar, R. (2008) foot note 318.

is considerable scope for third parties such as commercial and non-commercial entities to act as quasi regulators in the regulatory process. In the same vein, second parties (specifically businesses) may themselves carry out a self-regulatory role under programs such as Responsible Care whereby operators see themselves as having a social responsibility to carry out their activities sustainably.

Consequently, a typical regulatory enforcement pyramid for the present purpose can usefully be conceived of having three faces: each of the three faces representing, respectively, first parties (government), second parties (business), and third parties (commercial and non-commercial). Unlike Braithwaite's model where coercion comes only in government's action, escalation (i.e. increasing coercion) would be possible up any face of the pyramid. That is, it is possible to increase the level of coercion by escalating up the second face through self-regulation or up the third face through a variety of actions by commercial or non-commercial third parties or both.

To illustrate a situation how escalation can occur from up the third face of the enforcement regulatory pyramid, the following example will use the developing Forest Stewardship Council (FSC), a global environmental-standards-setting system for forest products. The FSC is overseen by the World-Wide Fund for Nature (WWF). It is a coalition of environmental groups, timber traders, indigenous people's groups, foresters, and community forestry groups. To certify forestry products to be sustainably managed, the FSC will both establish standards and will 'certify the certifiers' These practical standards rely on its influence in changing consumer demand by creating strong buyers groups and other mechanisms for institutionalising green consumer demand.[329] In other words, the ability of this platform to influence consumer demands shows the success. The involvement of government through formal endorsements and procurement policies that support the FSC makes it valuable. Nevertheless, the scheme is entirely a freestanding one and is entirely a third party based initiative: from base to peak, ranging from consumer sanctions to boycotts. This scheme invariably creates a new institutional system for global environmental standard setting which is independent of government.

Second, Braithwaite's model of enforcement pyramid is fashioned in such a way that a single instrument category is adopted to best tailor enforcement responses, specifically, state regulation, instead of being concerned with how best to utilise ranges of instruments to achieve the same sets of objectives. Conversely, the expanded pyramid proposed here contemplates the possibility of regulation introducing variety of various instruments across several phases of the pyramid or dimensions. It includes the escalation to higher thresholds of coerciveness not only within an instrument but across combinations of instruments and across various faces of the pyramid. Thus, the three dimensions of regulation encourages the possibility of escalating degrees of coercion through interaction among different and complementary instruments by beginning with one less intrusive instrument, such as business-initiated voluntarism or education (i.e. using second parties) but transcends to another instrument where the first exhausts its responsive potential by using third parties to audit the company or government mandated community right to know.[330] In the event that all prove abortive, higher coercive instruments such as government enforcement (command and control) or third party foreclosure of a loan is introduced to create conformity. Be that as it

[329]Erol, M. (1996). Look who's making the rules: The roles of the forest stewardship council and international standards organisation In: *Environmental Policy Making.* Paper presented to colloquium on emerging environmental policy: Winners and Losers, 23 September, Oregon State University, Corvellis.

[330]Zikargae, M. H. (2018). Analysis of environmental communication and its implication for sustainable development in Ethiopia *Science of the Total Environment,* Volume 634 pp.1593-1600.

may, the switch from one level of coercive instrument will not work effectively unless they are connected so as to enable a strategic escalation to the top when less coercive approaches fall through.

Joseph Rees, in his article "Hostages of Each Other: The Transformation of Nuclear Safety since Three Mile Island", provided a graphic illustration on how exactly this can occur when he analysed the highly sophisticated self-regulatory programme of the Institute of Nuclear Power Operators (INPO), which, post Three Mile Island, constituted may be the most laudable and effective scheme worldwide.[331] In spite of this scheme, it is incapable of working efficiently if it operates in isolation. Having done all, it is evident that there will be some industry non-conformists who do not respond to education, persuasion, peer group pressure, gradual nagging from regulatory agencies in the oil and gas industry, shaming, or the other instruments of informal social control at its disposal.

Even with this scheme, little progress was achieved in changing the behaviour of this minority. However, INPO encountered a dilemma as a handful of plants were ignoring the challenges INPO had identified yet going tough was not an option in the equation because that might result in forcing the non-conformist out of the association.[332] The INPOs only option after five years was to turn to the government regulator, the Nuclear Regulatory Commission (NRC). NRC involvement led to the dismissal of top executives, substantial improvements on safety and eventual plant shutdown. Calling the powers of the NRC which had the exclusive capacity to bring criminal proceedings and shut down plants made it possible for INPO to achieve these heights. Had the recalcitrant few not been dealt with by taking effective action against them, and in the longer term and free riders were permitted to continue with the necessary sanction, then INPOs authority over the firms would have been destroyed? What this portrays is that for the lower levels of the pyramid to function effectively, it might depend on the introduction of a peak, which in this sense is something only the government can do. Just as Rees pointed out that the achievement of the INPO was largely because they climbed on the shoulders of the NRC in dealing with the recalcitrant few.

Thus, the case above further exemplifies the importance of integration between the different levels of the pyramid. The same way the NRC did not result to threatening actions against the recalcitrant but were in touch with INPO which in effect, is a tiered response of education and information, escalating through peer group pressure and a series of increasingly threatening letters, ultimately to the threat of criminal penalties and incapacitation, of which criminal penalties can only be imposed by government. However, INPO in this regard could explore the option of issuing threatening letters to achieve its goal from operators.

This is an example of one of the most successful schemes of self-regulation ever documented, the presence of the regulatory gorilla in the closet was what made it successful. This is why this thesis tends to explore both regulation and liability schemes to achieve the much-needed sustainable shale gas development in terms of mitigating the highly probable risks of water contamination and use. A mix of government mandated information which is a modest interventionist strategy in integration with third party pressure at the higher levels of the pyramid might also be a veritable approach. For example, government should require fracking companies to disclose various information about the chemicals used for fracking operations, leaving ample opportunity for victims of frack accident to know who is responsible as well

[331]Sijakovic, M & Ana, Peric. (2018). Symbiotic architecture: Redefinition of recycling design principles. *Frontiers of Architectural Research*, Volume 7 pp.67-79.
[332]*See* supra Zikargae, M. H. (2018) footnote 330.

and so non-commercial third parties would have evidence to bring pressure on poor environmental performers.[333]

In sum, two general conditions make it unsuitable to adopt an escalating response up the instrument or enforcement pyramid in regulating shale gas extraction risks. First, in circumstances of serious risk of irreversible loss or catastrophic damage, a graduated response is inappropriate for the reason that the risks are too high: the victims of shale accidents may not be restored to the status quo, before the regulatory agency may be able to determine how high up the pyramid it is necessary to go to escalate to enforce compliance or change the behaviour of the target group.[334] In such situations using a horizontal rather than a vertical approach may be ideal where regulatory safety nets can be imposed simultaneously rather than sequentially.[335]

4.3.4 Principle 4. Promote Participants that are in the best position to act as Surrogate Regulators

For every regulatory process there are number of second and third parties, both commercial and non-commercial, who act as quasi regulators that contribute immensely to the success of the entire regulatory structure. These quasi regulators may range from industry associations who administer self-regulatory schemes in conjunction with financial institutions to environmental and other pressure groups. Regrettably, policymakers have completely ignored or for some reason avoided their valuable contributions to the point that they treat government as the sole regulator. For example, in the UK a move to a more determinative style of regulation decision making, whereby policy goals are prescribed by legislation and the role of the regulator is essentially to implement these goals, has removed much discretion from the regulatory process. Thus, even though greater rights for public participation have been introduced, many of the environmental standards the regulator must enforce have largely been predetermined at the legislative level, and expectations of what can be achieved through community participation may well be frustrated. If the regulatory structure can be expanded in a manner that accommodates additional players, the most serious vacuums that characterise the traditional regulatory approaches may be addressed.[336]

There are a few positive indices why the introduction of third parties into the regulatory process may provide for effective outcomes. First, companies respond more swiftly to the demands of quasi regulators than government interventions regarding an anomaly.[337] Take for example a threat issued by a bank to foreclose a loan to a company with low levels of liquidity is most definitely expected to have a greater impact in that, it will force the recalcitrant to heed policy requirements than existing government instruments or a combination of instruments. Second, there is this preconceived notion amongst firms that government mandated requirements are majorly built around political bias and compromise an influential few.[338]

Second, where such mandated imperatives come from commercial institutions, firms see them as legitimate per se. For example, the recent research note by The Hongkong and Shanghai Banking Corporation (HSBC Bank) a commercial bank in the UK dated July 18 said a second

[333]Mondello, G. (2015) Splitting nuclear parks or not? The third-party liability role. *Energy Economics,* Volume 51 pp.553-559.
[334]Nuttall, W. J *et al.,* (2017). Compensating for severe nuclear accidents: An expert elucidation. *Process Safety and Environmental Protection*, Volume 112 pp131-142.
[335]See supra Gunningham, N & Young M. D. (1997) footnote 304, pp.3-98.
[336]See supra Grabosky P. N. (1994) footnote 315 pp.419-48.
[337]See supra Yap, N. *et al.,* (2007) foot note 322 at p.283.
[338]Ibid.

Buhari (The incumbent Nigerian President as at 2017) term "raises the risk of limited economic progress and further fiscal deterioration, prolonging the stagnation of his first term, particularly if there is no move towards completing reform of the exchange rate system or fiscal adjustments that diversify government revenues away from oil."[339] Hence, the involvement of third parties in the process may well be important in terms of gaining political acceptability. Third, as already mentioned in the previous principle, government resources are limited especially in an era of fiscal constraint.

Consequently, it makes good business sense for government to set aside these resources for situations where no viable alternative exists but direct regulation. Fourth, even though resources are readily available, still government is not omnipotent because most areas of commercial and industrial activity like shale gas fracking are comprised of a myriad of small players that affect the environmental performance of industry where direct government influence is impractical. These small industry players are even difficult to identify let alone to regulate all of them.

Fifth, it is preferably advantageous to work in partnership with markets rather than against them. This interpretation does not mean a retreat into 'free-market environmentalism'. Rather this thesis acknowledges the place of market's power in changing and shaping industry behaviour and the extent to which this potential influence remains untapped. Accordingly, harnessing the power of the markets is a function of the involvement of second and third parties as opposed to direct government regulation.

4.3.5 Principle 5. Maximize Opportunities for Win-win Results.

One major setback that firms face in the conventional style of regulation is that there are hardly incentives for continuous improvement for environmental performance. For example, where the emission standards are placed at 100 ppm, no rewards are given to the firms to substantially make attempts to go beyond the set standards. The failure of the system to encourage companies to adopt pollution prevention approaches over end-of-pipe solutions (the same standard can be met by putting scrubbers on the chimney rather than developing cleaner technologies).

This also can be said of shale gas development where among the various fluid based hydraulic fracking techniques where the 'slickwater' fluid based hydraulic fracking technique is adopted by industry because of its cost effectiveness rather than going for the foam based hydraulic fracking technique which is safer but more cost intensive. If the industry had gone for the foam-based technique, it would be a good environmental performance criterion that regulation must consider.

The win-win outcomes principle encourages the ideal that the opportunities for both continuous improvement and accident prevention will be considerably enhanced to the extent that companies can achieve higher levels of environmental performance at the same time as increasing productivity or profits. This reiterates the justification for the need for innovative approaches for risk reduction in shale gas extraction activity. Therefore, once these innovative framework policy options are discussed, it will go a long way in ensuring that regulatory solutions optimise the opportunity for win-win results that facilitate and reward firms for going beyond compliance, while also maintaining a statutory baseline and a ratcheting up of standards. This, of course, happens to be a key challenge for policy making objectives and goals.

[339]Nigeria hits back at HSBC after Bank warns of economic stagnation. *Reuters,* New York Times, September17, 2018) [Online] www.nytimes.com (Accessed on 18/09/2018).

4.4 The Limits of Safety Regulation

To enforce safety requirements for the purpose of reducing the occurrence of harm resulting from a particular activity, regulators have adopted various approaches. These approaches could come in the form of a classical command and control approach. This style is such that the regulator sets specific standard requirements for regulated companies and enterprises, comprising of specific technological measures which ensure that the prescribed standard requirements are implemented in a satisfactory manner through regular inspection routines. This approach seems to promote fairness and clarity in the requirements. However, it suffers from some inherent problems which will be described below.

The second prescriptive one size approach to regulation could be the 'goal-based or outcome based' approach. Here the specific goals or outcomes are established by the regulator for the regulated firms without specifying how these goals and outcomes will be reached. This style encourages flexibility in allowing regulated companies to opt for the most effective approach to reach the objectives set by the regulator. But there appears to be difficulties in identifying accidents that have occurred for a long while. An example, is the contamination of ground water source where several operators are concentrated around the contaminated groundwater source. There is also the 'Process based' approach of regulation. For this, it the principal responsibility of the regulatory agency to identify key processes that are expected to engender safety performance by the regulated company. Such a process could be the establishment of a safety management system which requires regulated companies to implement them effectively.

This approach incorporates the regulator to be part of the stakeholders to observe and discuss management–level activities in regulated companies, but this might not be necessarily effective in ensuring good overall safety performance. Also, the 'self-assessment' approach requires the regulated firms to establish self-assessment programmes and identify areas relating to their activities and safety management that need extra attention. Likewise, they are given the opportunity to improve on the areas of weaknesses identified. This promotes a continuity in improving safety management but is ineffective if used as the sole regulatory requirement.

Having said that, it is important to note that these prescriptive one-size regulatory approaches have factors which inherently limits the effectiveness of regulation in general. These issues include:

4.4.1 Technological Innovation leading to Outdated Regulations

The shale gas industry through the innovation of the slick-water hydraulic fracking technique further reveals the static nature and outdated characteristics of regulatory approaches which sometime take a long time to be updated by the government. The changing technological landscape is often quick and rapid. As a result, these outdated processes can no longer adapt to dynamic innovations and end up requiring firms to implement techniques that are cannot address the issue of risk. For instance, decades-old regulations managed by the US Department of Transport require the headlights of cars commercialised in the USA to have a high and a low beam, and nothing else. This prevents manufacturers from introducing innovative new headlight designs which detect the presence of incoming traffic and adapt the beam shape to avoid dazzling incoming drivers.[340]

[340]See supra Robert, K. (1994) foot note 319 at p.109.

4.4.2 Regulator's Lack of Information on Risks.

A look at the activities of exploring for and exploiting for oil and gas resources deep underground, there a lot of complexities involved in terms of technological expertise, not least when talking about the new technique known as slick water hydraulic fracking. These and many more considerations make the industry highly technologically advanced. As a result, the regulators of such industries often find it difficult to appreciate the risks associated with the entire value chain of the activity or a product as well as the effectiveness of safety barriers. This leaves the regulator at the mercy of one who is knowledgeable in the field or at the whims and caprices of operators providing such risk information before the regulator can certify and give their approval regarding the safety design. However, this set back is less severe, or non-existent, in industries whose techniques are not relatively new as some have argued.

4.4.3 Regulators'Lack of Information on Costs and Benefits

For both the firm and affected parties to arrive at decisions which are compatible with the socially optimal level of prevention, regulators need to determine the costs of prevention required for each regulated activity and dividends of improved safety for potential victims. If companies do not shoulder the same costs due to their size, the productivity or the age of the facilities, regulators should ordinarily set different standards. Where same standards are set for companies, it would lead to over deterrence, whereby they meet standards that are too costly given the benefits or under-deterrence syndrome (having to meet more stringent standards at reasonable costs). It is expedient that regulators have to get information on victims' preferences as long as benefits are concerned. This is important because some victims prefer to experience more risks in as much as they pay less for the goods and services sought to be produced and rendered respectively by hazardous activities or more production and consequently more job opportunities. In real terms, the regulator is not privy to this information which makes the regulator formulate uniform industry standards that apply across the board, in spite of specific circumstances.

4.4.4 Regulatory Capture or Subversion

To adapt to these information disparities, there is this cooperation that is needed by regulators with firms and potential victims of hazardous activities to incentivise them to make known their costs and preferences respectively. As a result, this cooperative tie may result in the 'capture of regulators'[341] because the regulator relies on the firm and the victims to make an informed decision as to the compatible socially optimal level of risk reduction. This breeds a feeling of domination over the regulator by the firms or by the victims.[342]

Whilst regulatory capture regarding ethical lapses may appear extreme in the example given above, it leads to a situation whereby the regulator depends on the industry standards and expertise to make decisions. The industry formulates standards for which regulators regularly incorporate as voluntary industry standards.[343] In particular, this trend is prevalent in areas with a rapid pace of technological change. The effects manifest in loss of expertise and capability to independently assess the risks of operations involved.[344] Also, firms can escape

[341]Portman, M. E. (2014). Regulatory capture by default: Offshore explanatory drilling for oil and gas. *Energy Policy* Volume 65, pp.37-47.
[342]Olson M. K. (2014). Regulation of safety, efficacy, and quality *Encyclopaedia of Health Economics,* pp.240-248.
[343]Millstone, E & Lang, I. (2008). Risking regulatory capture at the UK's Food Standards Agency? *The Lancet,* Volume 372, Issue 9633.
[344]Lindøe, P. *et al.,* (2013). Risk governance of offshore oil and gas operations. (ed,) Cambridge University Press. Isbn: 978-1107025547, p.448.

fines or other penalties for regulatory non-compliance when public institutions become vulnerable to subversion orchestrated from bribery or intimidation. As Glaeser and Shleifer asserted, this can even lead to subversion of the legal system, and thus avoid civil liability by avoiding civil liability which is a more dangerous risk than that of subverting regulators.[345]

4.4.5 Verification Cost

During verifying a company's activities, regulators must embark on visits to sites, control and audit regulated facilities. These activities are costly and are supported by society. This is somehow surprising that regulators from an economist perspective they argue that regulations attract different costs whose costs exceed its social benefits.[346] Also, that this cost generates market inefficiencies and undermines economic growth. Regulators often lack the resources to monitor compliance with safety rules.[347]

4.5 Alternatives to Regulation

It is a fundamental basic prerequisite for regulation to be consistent and equitable, meaning that the same conditions apply across board within similar industrial operators and activities. This sparks off the situation for a detailed and prescriptive regulatory process, which requires specific types of technology for instance. This category of regulation is known as 'command and control' which have the tendency to impede incentives for technological and organisational innovation concerning safety. An intermediate approach that can address the loop-holes that C&C regulation is unable to meet is the use of legal standards in law. These standards attempt to provide adequate levels of safety especially in industries that experience constant change as it tends to integrate expert knowledge in a form which may change more rapidly than regulation.

The shale gas industry shares the same changing dynamic. A simplifying viewpoint on the distinction between a rule and a standard is that rules are applied ex ante, and standards ex post. For instance, a rule might provide a list of specific toxic substances which may not be released into the environment, whereas a standard might only ban the release of 'highly toxic' substances and leave the determination of which substances are 'highly' toxic to expert judgment, after the fact.[348] This is why this thesis seek to explore these alternatives to regulation. Industry players and professionals get involved to formulate the various rules and procedures that define what the current state of knowledge considers to be good practice in these regimes. The following are the three main alternatives to the traditional command and control regulation.

4.5.1 Liability Regimes

These regimes are applicable under the tort system. They can be quite punitive and rely ultimately on the coercive power of the state like the 'command and control' regulation.[349] Although they rely on the coercive influence of the state, they are not coordinated by the state. Rather they rely on private citizens to recognize injuries and enforce norms on one another.

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[345]Glaeser, E. L. & Shleifer, A. (2003). "The rise of the regulatory state." *Journal of Economic Literature*, Volume 41, Issue 2, pp.401-425.

[346]Finch, J *et al.,* (2017). Captured by technology? How material agency sustains interaction between regulators and industry actors *Research Policy,* Volume 46, Issue 1pp. 160-170.

[347]Hodge, G & McCallum, T. (2017). Public innovation: An Australia regulatory case study *Utilities Policy,* Volume 49 pp.20-29.

[348]Stimel, D. (2018). Paly Fair! Innovating internal self-regulation in the market for profit. *Business Horizons,* Volume 61, Issue 1 pp. 115-124.

[349]Oded, S. (2011). Inducing corporate compliance: A compound corporate liability regime *International Review of Law and Economic,* Volume 31, Issue 4 pp. 272-283.

This alternative shall be dealt with in detail in the next section since it forms part of the approaches which the thesis sees as a veritable means to mitigate the resultant risks associated with the health and environmental impacts of shale gas.

4.5.2 Market-Based Regulation

In this type of regulation, the regulator, to achieve their regulatory objective, harnesses the power of the market through the use of incentives, regulatory taxes, trading and subsidies to encourage compliance to safety standards. A best-known example of this market-based regulation is emissions trading. This scheme works by the regulator creating and overseeing a market in pollution credits that can be freely traded among regulated companies. The beauty in this emissions trading as well as regulatory taxes and other price-based schemes is that they seek to influence the behaviour of companies[350] in the market by distorting their incentive structure to take account of externalities.

4.5.3 Self-Regulation

These are voluntary programmes initiated by industry players that go beyond compliance, such as self-policing, auditing, information disclosures, contractual regulation, and stakeholder participation which shift responsibilities like standard-setting, monitoring and enforcement to private parties which have traditionally been assumed by governments.[351] The idea to self-regulate has been in existence in some professions like law and medicine for a long period of time. This assumption stems from the professional pride and interest for maintaining the reputation of the profession. This illustrates that one's own peers are the strictest regulators.[352]

From a legal standpoint, the idea of corporate and professional self-regulation refers to rules and standards formulated by an industry association to enforce voluntary compliance by its member of the same profession or industry. These may include voluntary policing and reporting schemes, the use of audits, and schemes to increase the involvement of community stakeholders in the regulatory process. These kinds of programs attempt to internalise certain key aspects of the rule of law within regulated activities. A typical example in the safety area as the thesis is about reducing risks resulting into harm is the American Petroleum Institute (API) standards and recommended practices for oil and gas companies as well as the chemical industry's Responsible Care programme.[353]

Unlike liability regimes, self-regulation shares the same characteristics as it acts primarily *ex ante*, prior to the occurrence of any incident. The rationale is that the informational advantage industry experts enjoy over government regulators creates room for firm specific standards as against industry wide standards formulated by government regulators. Nevertheless, self-regulatory schemes could act *ex post*, for example in situations where punishment is to be given to offenders for engaging in corporate malpractices.

Although self-regulation as an alternative to traditional styles of regulation has generated heated debates in the legal community over the past decade because of the assumption that it

[350]Wilson, E. J et al. (2009). Assessing a Liability Regime for Carbon Capture and Storage *Energy Procedia,* Volume 1 Issue 1 pp. 4575-4582.
[351]Nielsen, K. S. (2017). From prediction to process: A self-regulation account of environmental behaviour change *Journal of Environmental Psychology,* Volume 51, pp.189-198.
[352]A paper by the National Audit Office of the UK government. (2014). Using alternatives to regulation to achieve policy objectives. *Better Regulation Executive* [Online] https://www.nao.org.uk/wp-content/uploads/2014/06/Using-alternatives-to-regulation-to-achieve-policy-objectives1.pdf (Accessed 19/09/2018).
[353]Marcovici, M. (2013). The Fracking Debate, Published in the USA.

is subject to adverse selection, e.g. firms who participate in the programme do not improve their real performance in circumstances where there are no sanctions and lower quality companies will opt to participate in order to benefit from the reputational advantages the members enjoy without being made to bear the costs of change, self-regulation tends to be efficient in that private bodies have access to higher quality information than state regulators. This makes the former to monitor and enforce standards more cheaply and it is easier for them to update standards, so they meet up with the evolving industry technology.

In addition, self-regulation of safety issues has suffered a lot of backlash from several authors:[354]

1. Experience since the industrial revolution suggests that it does not generally provide a sufficient assurance of social control over the hazards caused by industrial activity.[355]
2. It does not constitute a means of control which meets at least two legal criteria for fairness:
    - predictability of what is required of companies;
    - equivalent protection for workers and other persons at risk across different sectors of society.
3. There is also the issue of protection of management discretion and propriety information in a self-regulated industry which makes the process opaque. What this mean is that public workers are not given access to company information, particularly those that reveal the trade-offs made between safety and production or profit in the conduct of company operations. Therefore, it encourages a business as usual mentality in arriving at how safe is safe enough for such operations and further neglects public contributions and interests as a way of participating in safety safeguards initiatives unless special safeguards are provided by government oversight and competence. Thus, such proprietary protection of company information and discretion is completely at odds in many evolving democracies and negates the very idea of transparency, stakeholder participation and company accountability in handling risks.
4. In addition, it is a general norm for self-regulation to adopt voluntary codes of practice or standards initiated by industry or trade organisations. However, where member organisations put some short-term pressure on industry bodies who do not have the required sufficient level of independence responsible for the formulation of high quality standards, they end up reducing such self-regulatory voluntary standards for members to follow. This invariably makes standards weak for reducing the associated risks.
5. To ensure the sufficiency of each company's safety management system, there is need for government to oversee the self-regulated approach adopted by the industry. This oversight inspection function can be carried out by the agency, by third party inspection and certification or by review of self-audit reports. This inspection and certification exercise is difficult because the effective evaluation of

[354]These criticisms is based on a presentation by Prof. M. Baram at the 2010 working on safety conference.
[355]Short, J. L. & Toffel, M. W. (2010). Making Self-Regulation More Than Merely Symbolic: The Critical Role of the Legal Environment. *Administrative Science Quarterly*, 55:361–396. Available [Online] http://scholarship.law.georgetown.edu/facpub/461. (Accessed 23/07/2018).

the extent of compliance lies in the agency's expertise and access to company held information.

In spite of these backlashes, self-regulation is advantageous in that it can engender a degree of ownership of regulation within industry. Traditional C&C type of regulation centres on the imposition of explicit standards backed by criminal sanctions. The idea behind it at the end of the day is to apply criminal sanctions by an external regulator or court after a violation has occurred. Whereas, the focus of self-regulation which gives a sense of complete ownership of regulation to the regulated to ensure compliance is focused on performance or outcome based. It is about making sure the policy objective is achieved rather than the means through which it is achieved. By focusing on results (outcomes) rather than on the means for achieving them (inputs), self-regulation and other alternatives to traditional C&C regulation permits entities greater freedom of action to find the lowest-cost or best means of complying for itself. Outcome oriented standards can improve compliance by mitigating the costs of compliance with technical rules nd fostering innovation to source the most effective means to reach socially desired outcomes.

A typical example is the Amoco Yorktown experiment. In this experiment, it was found that if the EP had applied outcome standards for benzene emissions to the whole of Amocco's Yorktown plant, rather than specific rules mandating certain technology in the smokestacks, Amocco would have been able to achieve greater emissions reductions at much lower cost. The U.S. EPA, had a rule which require specific equipment be installed in smokestacks to filter benzene. Amocco spent $31 million on compliance in its Yorktown, Virginia refinery.[356] A partnership in 1990 between Amocco and the U.S EPA was formed to study the pollution reduction possibilities at the refinery. They also commissioned a non-profit environmental research group to peer review their findings. It was discovered by the study that the refinery was emitting the most significant volume of benze not via the smokestacks but at the loading docks where gasoline was being pumped into barges. Ironically, Amocco would be able to achieve the same level of emissions reduction required under the U.S Clean Air Act for a quarter of the cost (USD$10 million instead of USD$40 million) if the EPA would allow Amocco to decide where the money should be spent through innovations in process engineering, rather than applying specific rules requiring smokestack technology.[357]

Another example where self-regulation proved successful in fostering compliance is through the efforts of the U.S Occupational Safety and Health Administration (OSHA) in Maine known as the U.S OSHA's Maine 200 Programme. In this information analysis to identify possible targets for inspection and improve compliance in a particular risk group within the work place. There was a compliance problem and as such an agency within the US Department of Labour seeks to protect the life and health of American workers primarily through direct regulation of employers. The regulatory enforcement system does not address the unique hazards of each work site. New standards are constantly being made to apply to all worksites and an adversarial approach is taken to inspections. Yet OSHA has only limited financial resources. It has been estimated that each worksite can expect a random visit once every 87 years on average.

The state of Miane had the highest rates of workplace accidents in the United States-71% above the national rate. Maine OSHA identified three problems with its traditional regulatory

[356]Schmitt, R. (1994). "The Amocco/EPA Yorktown experience and regulating the right thing", 9(1) Natural Resource and Environment, 11-13, 15.
[357]Philip, H. (1994). The Death of Common Sense, Random House, New York, pp.7-8.

approach of targeting inspections without regard to worksite conditions at individual establishments:[358]

- The inspections system (which relied on national industry data to identify industries with higher accident rates for targeted inspection) rarely targeted large employers outside of manufacturing, where many injuries occur.
- Once chosen for an inspection, the firm was evaluated only for regulatory compliance with OSHA standards and not workers safety and health outcomes.
- Inspections were designed to place OSHA in an adversarial role, looking for violations rather than working with well-intentioned managers who would have addressed a hazard upon learning of it.

To address these problems of traditional regulatory approach, an innovative solution was devised. The Maine OSHA office used workers compensation database to identify the 200 employers with the highest number (not rate) of injuries and illness in their area. Rather than instituting adversarial inspections, OSHA requested their co-operation in improving work conditions by committing to a comprehensive safety and health programme that includes employee participation, self-inspections, identification of worksite hazards, and training programme to mitigate and prevent hazards and quarterly reporting to OSHA. Thus, employers who chose to accept OSHA's request received a significant lower priority for inspections and higher priority for technical assistance. The others would be targeted for inspection due to their risk prioritisation. All but five of the firms chose to submit adequate health and safety plans. OSHA maintained authority to address serious problems through regulatory enforcement, but this was to be a last resort against recalcitrant employers, not a standard procedure. In this way OSHA sought to leverage its authority and address hazards specific to the worksite through a partnership that gives employers and employees ownership of workplace health and safety regulations. The result of this innovative solution is as follows:

- As of December 1995 (nearly two years into the programme), participating firms identified 180 000 hazards and abated over 128 000 of those hazards (in comparison with the 36 780 that OSHA inspectors had discovered and cited in the previous eight years at those sites).
- Total workers compensation claim dropped by 47.3% in those worksite during the programme between 1991 and 1994 (all Maine employers experienced a drop of 27% over the same period).
- At least 320 worksite health and safety committees were established.
- OSHA's traditional inspection approach required the effort of six to nine inspectors to inspect all large paper plants in Maine. Maine 200 reached roughly 200 firms in a single year through self-assessment combined with traditional enforcement for the firms who did not agree to establish safety and health programmes.[359]

The Rugmark Foundation is another handy example to sheds additional light to how self-regulation and other use of standards for internal management systems as an alternative to traditional C&C regulation has proved successful in achieving certain level of compliance in a business environment. Although this example is not directly related to the energy industry, valuable lessons can be drawn for application in the energy industry especially the oil and gas

[358]Chenok, D. (1997). U.S Office of Management and Budget.
[359]Sparrow, M. (1996). Regulatory reform: Lessons from the Innovations Awards Programme" Mimeo, John F. Kennedy School of Government, Harvard University.

industry where compliance is an issue. The compliance in this instance was that it was discovered by the institution regulatory the codes of conduct of rug sellers in South Asian and rug and carpet industry that there was allegedly widespread child labour violations which negates international and many countries' labour standards. Rugs and carpets are exported to Western nations where consumer concern about child labour is a critical subject. The situation became complicated because Western governments where this rugs and carpets where exported to had no jurisdictions or authority to interfere in the internal legal issues prevalent in South Asian countries directly.

The Rugmark Foundation established in 1994 by a coalition formed between Indian human rights and industry groups and the United Nations Children's Fund created devised an innovative idea where retailers and manufacturers bind themselves to a code of conduct whose aim was to replace child labour with adult labour and the provision of educational resources for former child workers. Licensing fees were paid to the Foundation by signatories which employs monitors to conduct inspections by these monitors. Hence, signatories who pass their inspections can comfortably affix the Rugmark label, a smiling carpet, to their products. As a result of this internal standard management codes of conduct, over 260 000 rugs were certified with labels since 1994 have been exported to Germany which accounts for more than 30% of the market.[360]

As safety schemes are developed and often administered by firms, it can reduce administrative costs for government and compliance costs for companies. Rulemaking may be better equipped with the right information so that they can be tailored to specific needs, meaning the regulation of better targeted.[361] These risks mentioned by authors above can be mitigated through effective designing of self-regulation. This comprises of a transparent process, introducing independent and accessible conflict and dispute resolution mechanisms, and getting a wide range of stakeholders involved in the rule making process.[362]

4.6 Summary

From the above discussion regarding the principle that shape regulatory design for risk mitigation, it is important to note that policy makers should understand that there is no one best method to design an effective regulatory framework. Environmental regulatory problems are highly complex in that there are issues of vested interests to meet. Thus, an effective regulatory design must take into account these conflicting interests so that all of those who might be impacted by that regulatory design have a level playing ground.

However, there is one common trend that this thesis has observed that cannot be compromised whilst designing a regulatory framework. This common trend is that, whatever design adopted must have the ability to punish offenders and at the same time give incentives for performing companies. Again, this section has illustrated vividly that whilst some environmental or human issue require either one or two or a combination of all model regulatory design, some totally require just one model of regulatory design.

More so, the sections has illustrated that certain group of firms and companies do not welcome some particular or alternatives to regulation. For example, it is often believed that small firms and companies are not comfortable with performance based regulatory policy design strategy because these market based performance regulatory alternative impose a greater responsibility

[360]Liubicic, R. (1998). "Corporate codes of conduct and product labelling schemes: The limits and possibilities of promoting international labour rights through private initiatives," 30 *Law & Policy in International Business*, p.111-158

[361]See supra Indiana Harbor Belt R.R. Co. V. Am. Cyanamid Co foot note 37 at p.16.

[362]Ibid.

to develop appropriate compliance strategies and create uncertainty as to what is required for compliance.[363]

An effective regulatory design or alternatives to regulation should necessarily require that those being regulated should have the ability to develop and implement compliance strategies based on a sound understanding of the objectives and standards set out in the regulation. Likewise regulatory design and alternatives for risk mitigation should take into consideration the peculiar characteristics and capacities of the regulated group and the possible effect of adopting such documents on compliance efforts and measures.

Having shown the limitations in regulation, the thesis demonstrates that self-regulation with its dangers have the greatest advantage because it has the ability to ensure the effectiveness of regulation beyond mere compliance. It also has the incentive to achieve policy outcomes and self-sustaining. Self-sustaining here simply means that it has the ability to be adaptive to the problems in future by proposing progressive changes to deal with new challenges that were not foreseen from the beginning. This is based on the idea that, where industry operators are given the right freedom to an extent, operators are likely to prove more effective in identifying hazards and developing lowest-cost measures than is a central regulatory authority under a traditional form of regulatory design.

However, the work in this section reveal that self –regulation which is anchored on the premise of performance based regulation shows some disadvantages which include: the uncertainty regarding what constitutes acceptable compliance, the fact that it is only suitable in situations where the regulated firm is in a better position than the regulator to understand and solve the potential causes of accidents or problems that the regulation is supposed to address and it may be difficult for regulators to monitor and enforce compliance with broader standards, and it will generally be unsuitable where regulators cannot monitor the outcomes at all (e.g oil discharge on the open sea).

From the above disadvantages it is clear that the push for a self-regulatory approach as a complement to C&C regulation in the energy industry fits perfectly based on the second point. The energy industry is such that suffers from this knowledge disparity between the regulator and the regulated entity regarding their ability in solving the potential causes of accidents or problems that regulation is supposed to solve. Because the regulated entity is in better position of understanding of these problems, the regulator can achieve little in enforcing full compliance even with the best monitoring strategies in place. Thus, a self-regulatory approach helps solve this imbalance.

Nevertheless, it is pertinent to note that if regulatory strategies such as self-regulation and internal management standards are to be deployed as alternatives to formal rules, they should be accompanied by government input, support, and monitoring to achieve the policy objective. This is crucial because results have shown that compliance with purely voluntary efforts is likely to be patchy unless they are backed by either sanctions or other incentives for compliance by government.[364] These sanctions or incentives does not have to be legal. It could be a special recognition permitting such performing or compliant entity to use a logo such as the Japanese privacy mark, or, as a negative sanction could the naming of a company as a company that is out of compliance in Parliament or a press release.

[363]OECD (2002). Reviews of Regulatory Reform: Regulatory Policies in OECD Countries. Isbn 92-64-19893.
[364]See supra Portman, M. E. (2014) footnote 341.

Chapter 5

5. Case Study Review of the Liability Regime and Problems of Liability and Regulatory Systems.

This Chapter began to explore the arguments for and against environmental liability and regulatory systems as means for mitigating risks. Highlights the reasons why regulation and liability systems will turn out ineffective in managing the risks associated with gas fracking, particularly given the likelihood that states rich in shale resources are interested in relaxing the regulatory regimes applicable to the activity of gas extraction. Here the USA's regulatory and liability regimes shall be examined to bring out the above preposition. Though from the review case study you would see that the liability and regulatory regimes are crafted in a manner that promotes strict environmental regulatory reform.

This section lays the foundation for the arguments that water contamination claims should be subject to strict liability offence that does not require proof of negligence or omission before an operator can be held liable. This work in this section also explores the factors responsible for making liability and regulation ineffective in mitigating risks.

5.1 Introduction

The U.S play a major role in the whole issue surrounding shale gas fracking within the current energy extractive industry. This is because other shale gas rich states look forward to replicate the success of the U.S in the extraction of these resources. However, a close look at the factors responsible for this success is dependent on a lot of factors which are unique to the U.S experience. For example, the nature of mineral right ownership of the U.S is different from most civil jurisdictions, some of the locations where these shale resources are located are not as densely populated when compared to other regions, some provisions in the U.S oil and gas statutes governing the activities of shale gas fracking have been relaxed for the shale gas industry to mention but a few.

Thus, it is pertinent to examine the relevant laws that relates to the liability of the operator of an activity like shale gas fracking. The aim of the thesis here is to show that the U.S legal and regulatory framework is in support of a strict environmental liability approach in tackling risks associated with fracking. A comparative discussion of these various states regulatory approach shall be explored too in order to prove further that whilst some states are very strict in terms of regulation, other have relaxed their approach to attract investment. This case study shows that those states that impose strict environmental liability systems account for an effective regulatory shale gas extraction. For instance, the Comprehensive Environmental Response, Compensation Liability Act (CERCLA) provided for limited defences for an operator, extended the definition of who liable parties are, proposed a strict, joint and several liability for a range of substantial response costs, etc.

The other ambit of this Chapter is to bring to the reader the problems inherent in liability and regulatory systems. This thesis in this Chapter also explores the factors that should justify the application of strict liability to water contamination risk associated with shale gas extraction and gave certain legal principles to hinge this argument and contributions of this thesis. The overall aim of this section is emphasizing on the benefits of self-regulation which improves liability for the governance of shale gas extraction.

In practice, direct traditional regulation has this inherent insufficiency to address many of our environmental problems, no matter the level of skills involved in drafting and how much is directed toward enforcing them. Three different illustrations can be cited. The first relates to when the available legal and policy instruments are no long enough to address the challenge,

as for example air pollution issues, which are predominantly caused by mobile sources not suitable for command and control approach as industries smoke stack emissions. The other ambit relates to problems not suitable or contemplated by direct traditional regulation and when direct regulation standards are not appropriate to deal with them or are inexistent. The last centres on "new problems" for which individual action is not enough to address them. These problems include climate change effects.[365]

5.2 Liability Regimes and Prevention

Having seen what regulation means from the working definition above, the various forms, and alternatives to regulation as well as several factors limiting the effectiveness of regulation from an oil and gas industry perspective, it is pertinent to now examine what a liability regime is in relation to prevention as a principle in law in reducing risks in shale gas development. This section will also highlight the effects of liability law and how it either spurs or deters firms and individuals to take care. A consideration of certain factors which inhibits the effective application of liability as an incentive to invest in prevention shall be described too. With reference to corrective justice theory in law and ethics, the complementary nature of liability regimes and regulation is discussed here too. In the same vein, some indirect benefits of liability law shall be explored. As a way of comparison, the indirect costs of liability law, including their negative impacts on innovation will be analysed too. Accordingly, to achieve all of these, this thesis will begin by providing introductory definitions of important terms relating to tort law, civil liability and negligence.

5.2.1 The United States' Applicable Liability Regimes

This section will examine the environmental liability regimes within the legal frameworks of various state's jurisdictions in the US to ascertain the form of applicable liability in terms of environmental and health impact incidences resulting from certain hazardous activities. The US as a jurisdiction is explored due to the important competitive role it plays in certain economic fields. Also, the US jurisdiction is chosen because of its relevance in the context of advanced shale gas development as well as its importance in international debate on this subject.

The comparative analysis here does not assert to be comprehensive. Rather it focuses on particular laws aiming to look at how they work in practice instead of simply looking at how they appear in the legislative texts. It is pertinent to note the applicable liability regime in this jurisdiction because it takes centre stage of discussion when one talks about hydraulic fracking and more, so such discussions could eventually shape the outcome of decisions in other nations for fracking activities. Therefore, if this thesis identifies the liability regime, it will help strengthen whatever form of liability regime that the thesis intends to propose as a precautionary measure to mitigate water contamination in fracking.

At both federal and state levels, the USA evidences different environmental liability regimes, with differing rules for environmental activities. The danger with such a situation is that it can create problems of unpredictable enforcement for the regulated community. However, it has the advantage of allowing the authorities, at their individual level, the ability to opt for the most severe out of several regimes where they are averse to that activity. Generally, statute law at either federal or state level addresses environmental damage which contains a mix of administrative, civil and criminal provisions, whereas common law rules of liability govern traditional environmental damage.

[365]See supra Robeiro, F. M & Kruglianskas, I. (2013) footnote 139

The Clean Water Act (CWA) of 1972,[366] the Resource Conservation and Recovery Act (RCRA) of 1976, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund Act) of 1980[367] and the Oil Pollution Act (OPA) of 1990[368] are the fundamental statutes containing liability and clean-up provisions. Despite differences among these laws, they carry some common characteristics, such as: wide disclosure and notification requirements; strong enforcement powers; exceptionally high administrative and criminal penalties; broad public participation; strict, joint and several liability for a range of substantial response costs; wide definitions of the liable parties; very limited defences; and liability irrespective of when the actual pollution occurred.

CERCLA, also known as 'Superfund' is the most famous of these laws adopted in 1980 to address the highest priority issue of uncontrolled or abandoned hazardous sites. Liability under this law is strict, joint and several and retroactive. However, these terms do not appear in the statute. CERCLAs liability does not apply to personal injury or property damage, although plaintiffs in common law actions can leverage on the health studies and information disclosure requirements to support their claims. The standards for clean-up is very demanding, at least in principle, and the remediation process is a cumbersome one comprising procedural steps and powers, aimed at keeping the liable parties perpetually responsible even after the completion of the project through 're-opener' clauses.

Current owners and occupiers, past owners and occupiers, hazardous substance and generators and transporters are some of the categories of potentially responsible parties recognised under CERCLA. The addition of generators has widened the catalogue of liable parties at some sites. Liability may include individuals, associations, consortia and joint ventures, as well as secondary parties such as successor and parent companies, shareholders, directors and officers, trustees and others backed up with the decisions of many courts regarding the primacy of the statute over any corporate protections. In as much as the burden of proof saddled on the plaintiff is not formally jettisoned, the duty to prove causation, in a direct sense, is not always necessary.[369]

However, there are three narrowly construed forms of defences which are almost worthless: (i) an innocent purchaser's defence which is very demanding to prove, (ii) a 'federally permitted releases exemption which also offers exceptionally narrow protection; and (iii) a long way short of permit compliance defence.'[370] Under CERCLA, courts have routinely ruled that harm is not divisible when it comes to multiple party cases due to mixture of different parties' substances in the ground. Nevertheless, a detailed scheme of settlement has been

[366]333 U.S.C. S.1251 et seq (1972) The Clean Water Act (CWA) establishes the basic structure for regulating discharges of pollutants into the waters of the United States and regulating quality standards for surface waters. The basis of the CWA was enacted in 1948 and was called the Federal Water Pollution Control Act, but the Act was significantly reorganized and expanded in 1972. "Clean Water Act" became the Act's common name with amendments in 1972.

[367]The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, was enacted by Congress on December 11, 1980. This law created a tax on the chemical and petroleum industries and provided broad Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health or the environment

[368]Oil Pollution Act of 1990. The Oil Pollution Act of 1990 (OPA) (101 H.R.1465, P.L. 101-380) was passed by the 101st United States Congress and signed by President George H. W.

[369]Burlington N. & Santa Fe Ry. Co. V. United States, 556 U.S. 599 (2009)

[370]Ibid

formulated, with liability mostly divided in line with equitable criteria and the authorities granting protection to settling parties.[371]

Apart from CERCLA, other federal statutes such as RCRA, CWA and OPA all provide for similar liability regime standards though a narrower definition of a liable party. For claims touching on pure economic loss, it has been brought under OPA as a piece of legislation. Whereas claims for traditional damage have been brought under common law rules, which comprise a blend of strict and fault-based liability even though it varies from state to state. Large companies are always willing to settle strict liability actions for property damage, reason being that courts may alleviate the burden of proving causation and negligence.

Now having seen that the above-mentioned laws also regulate the operations of shale gas development, why then should the shale industry not be subjected to a strict liability regime in order to achieve maintain the tenets of the PP that is missing in shale oil and gas development activity. Therefore, it is the postulation of this thesis to say that it would not be inequitable if shale gas development is subjected to a strict liability regime as it merits the abnormally dangerous activity status from time immemorial.

It is important at this juncture for a brief understanding of the current regulatory and political environment surrounding fracking to further strengthen the proposal being sought in this thesis to govern the operations of shale gas development. Quickly, an examination of the exemptions the industry has enjoyed from a federal regulatory point of view in accordance with some legislative documents in the US is important.

Under CERCLA potentially responsible parties comprise several categories *inter alia* including current owners and occupiers, past owners and occupiers, hazardous substance generators and transporters are some of the recognised categories.[372] The addition of generators has widened the catalogue of liable parties at some sites. The liability regime may apply to individuals, associations, consortia and joint ventures, as well as secondary parties such as successor and parent companies, shareholders, directors and officers, trustees and others. This regime is backed up with the decisions of many courts regarding the primacy of the statute over any corporate protections. The duty to prove causation, in a direct sense is not always necessary as long as the burden of proof saddled on the plaintiff is not formally jettisoned.

5.2.2 Approaches to Federal Regulation of Hydraulic Fracturing

Despite the extremely controversial debate regarding hydraulic fracking, it has received several significant exemptions from federal environmental regulations in the US.[373] For example, according to SDWA, all underground injections within the Underground Injection Control (UIC) programmes are required to be regulated by the EPA. What this implies is that an applicant has to possess a permit to conduct underground injection activity.[374] Prior to this, the applicant was only entitled to a permit once they had shown that the underground injection

[371]See Astm e1527-13 standard practice for environmental site assessments: phase 1 environmental site assessment process (Am. Soc'y Testing & Materials Int'l 2013), Available at http://www.astm.org/standards/e1527.htm.

[372]Ibid.

[373]U.S. Energy Information Administrative Department of Energy, Energy Price Impacts on the U.S. Economy 6 (2001), *Available at* http://www.eia.doe.gov/oiaf/economy/energy_price.pdf; Wiseman H., (2010). *Regulatory A*daptation in Fractured Appalachia, 21 Vill. *Environmental Law Journal* 229, 229–30 at p.243.

[374]42 U.S.C. § 300h (B) (1) (A) (2006); Legal Envtl. Assistance Found. Inc. V. EPA, 118 F.3d 1467, 1474 (11th Cir. 1997) (stating that it is "clear that congress dictated that all underground injection be regulated under the UIC programs").

exercise will not endanger drinking water sources.[375] The EPA did not include hydraulic fracking to be an underground injection before 2005 and as such the requirement for a permit was not necessary by the applicants.[376] However, in 1997 a court in Alabama ruled that the EPAs interpretation of 'underground injection' was misleading and that hydraulic fracking should fall under the SDWA.[377]

Consequently, the EPA issued a study on hydraulic fracking and its effects on the environment in response to the ruling of the court.[378] The report of the study did not reveal any casual connection between contamination cases and injecting fracking fluid into coalbed methane wells.[379] Due to this report, the conclusion of the EPA was that the environmental effects of hydraulic fracking did not merit further study. Nonetheless, several people within and outside the agency questioned the methodology and impartiality adopted by the expert panel that reviewed the EPAs findings.[380] One of the issues raised was that the study was limited in scope and focused on the underground injection of fluids to ascertain the cause of contamination of underground sources of drinking water.[381] Further criticism was that the EPAs study failed to investigate the effects of fracking in shale formations.[382]

Despites these reasons surrounding the EPA study, hydraulic fracking was officially exempted by Congress from EPA regulations in the 2005 Energy Policy Act.[383] This Act is famously known as the 'Halliburton Loophole' as the Act provided fracking leverage to continue whereas other types of drilling and mining had to be governed by EPA regulations.[384] As a result of the effect created by the revamping regarding the SDWA, there was a brief pause in the legal and political debate over whether regulation should be provided by the federal government.[385] The debate to repeal the exemption being enjoyed under the SDWA was renewed in 2009 when Democratic members of Congress introduced twin bills. This bill, the Fracturing Responsibility and Awareness of Chemicals Act of 2011[386]was targeted toward

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[375]Legal Environmental Assistance Foundation. 118 F.3d at 1474.

[376]See supra Blackstone, A. (2012) footnote 65

[377]Legal Environmental Assistance Foundation., 118 F.3d at 1474; *Alabama Lawsuit Poses Threat To Hydraulic Fracturing Across U.S.*, Drilling Contractor, Jan./Feb. 2000, at 42, *Available at* http://www.iadc.org/dcpi/dc-janfeb00/j-coalbed.pdf. (Accessed on 09/01/2017).

[378]EPA, Evaluation Of impacts to underground sources of drinking water by hydraulic fracturing of coalbed methane reservoirs; National Study Final Report 1 (2004), *Available At* http://www.epa.gov/ogwdw/uic/pdfs/cbmstudy_attach_uic_final_fact_sheet.pdf. (Accessed 11 January 2017)

[379]Ibid.

[380]Environmental Protection Agency, EPA, Findings on Hydraulic Fracturing Deemed "Unsupportable," Union of concerned scientists: citizens and scientists for environmental. Solutions, http://www.ucsusa.org/scientific_integrity/abuses_of_science/oil-extraction.html (last visited Jan. 19, 2012) [hereinafter union of concerned scientists]; Todd Hartman., (2005). *"He's Either Loved or Reviled": EPA whistle blower stands up to agency*, Rocky Mountain News [Online] http://www.m.rockymoutainnews.com/news/2005/may/31/hes-either-loved-or-reviled/.

[381]Wiseman, H. (2009). Untested Waters the rise of hydraulic fracturing in oil and gas production and the need to revisit regulation, 20 *Fordham Environmental Law Review*. 115, 128.

[382]Ibid.

[383]Mulkern, A. C. (2009). *Industry Campaign Targets 'Hydraulic Fracturing' Bill*, N.Y. Times http://www.nytimes.com/gwire/2009/05/07/07greenwire-industry-campaigntargets-hydraulic-fracturing-10572.html. (Accessed on 12/01/2017).

[384]Editorial. "The Halliburton Loophole (2009). New York Times at 28; Regulation of hydraulic fracturing by the Office of Water, Environmental. Protection. Agency, http://water.epa.gov/type/groundwater/uic/class2/hydraulicfracturing/wells_hydroreg.cfm#safehyfr (last visited 12/01/2017).

[385]See supra Blong, R. (1996) footnote 73 at p.116.

[386](H.R. 1084, S. 587, dubbed as the FRAC Act) is a legislative proposal in the United States Congress to define hydraulic fracturing as a federally regulated activity under the Safe Drinking WaterAct.

repealing the exemption for hydraulic in SDWA but they were never reported out of committee.[387]

Even among environmentalists there are disagreements due to the complexity of the debate characterising hydraulic fracking.[388] Some environmentalists are in support of fracking because they believe natural gas emits less GHG than either oil or coal.[389] Also, that natural gas could become the primary source of electricity in the US and serve as a transition fuel, from carbon-heavy sources to renewable sources, while awaiting the development of renewable sources.[390] Hydraulic fracking is also plagued with certain other statutory loopholes which can be found in other environmental statutes. For example, there is no requirement for oil and gas producers to make an annual report of their releases of toxic chemicals. This is contained in the Emergency Planning and Community Right to Know Act.[391] Proponents of fracking argue that the fracking fluid does not have a chance to pollute ground water because it enters the earth far below the water table, not minding the fact that CWA prohibits oil and gas operators from discharging pollutants into US water without a permit.[392] As a result, a number of states and towns affected by fracking are making efforts to regulate the process due to these gaps in the Federal regulation of hydraulic fracking.[393]

5.2.3 Approaches to State Regulation on Hydraulic Fracturing

While states in the US are at liberty to regulate the practice as they see it fit, the Federal Government, through the SDWA, currently exempts most hydraulic fracking activity regulations.[394] In the past, regulatory programmes and state oil companies only focused on managing petroleum reservoirs, efficient production, and addressing mineral rights issues. However, in recent times, there has been a slight adjustment in the sense that these programmes focus more on environmental safety.[395] The Ground Water Protection Council (GWPC) in conjunction with the Interstate Oil and gas Compact Commission (IOGCC),[396] reported that there are laws and regulatory requirements that protect water resources during oil and gas exploration and production activities which major oil and gas production states have and operate with.

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[387]Fracturing Responsibility and Awareness of Chemicals (FRAC) Act, S. 1215, 111th Cong. (2009) (As Referred to Senate Env't and Pub. Works Comm.); H.R. 2766, 111th Cong. (2009) (as referred to the subcomm. on energy and environment).

[388]CKrauss, C & Zeller, T. (2010). When a rig moves in next door, New York Nov. 7 at BU7; Ian Urbina., (2011). Pressure limits efforts to police drilling for gas, *New York Times*, March 4 at A1.

[389]Ibid.

[390]See supra Blackstone, A. (2012) footnote 65.

[391]Ibid at p.243.

[392]Dubois, S. (2010). *Does the EPA have the tools to regulate fracking?* Fortune: CNN Money.Com 2http://money.cnn.com/2010/10/01/news/companies/epa_clean_water_act_fracking.fortune/index.htm. (Accessed12/01/2017).

[393]Deweese, W. (2010). Fracturing Misconceptions. A history of effective state regulation, groundwater protection, and the ill-conceived FRAC Act, 6 Oklahoma. *Journal of Law & Technology*. 49, *22–32 http://www.okjolt.org/images/pdf/2010okjoltrev49.pdf. (Accessed 14/01/2017).

[394]Kell, S. (2009). Congressional Testimony….. Statement of Scott Kell on behalf of the Ground Water Protection Council, (GWPC) House Committee On Natural Resources Subcommittee On Energy And Mineral Resources Washington, D.C. June 4, 2009 http://www.gwpc.org/elibrary/documents/general/kellhousetestimony6-4-2009.pdf; Tiemann M & Vann A., (2013). Hydraulic Fracturing and Safe Drinking Water Act Regulatory Issues, Congressional Research Service Report for Congress10th January, at p.33.

[395]Tiemann. M & Vann, A. (2013). Hydraulic Fracturing and Safe Drinking Water Act Regulatory Issues, Congressional Research Service Report for Congress10th January, at p.33.

[396]The Interstate oil and gas compact commission represents the state oil and gas agencies. The Commission was established in the 1930s, initially to reduce the waste of oil during exploration and production by developing model statutes and practices to improve the conservation of oil resources.

As a result of the unique role of the states as well as their collective effort on matters relating to the oil and gas industry, it has been proposed by some to remain the responsibility of the States.[397] Therefore, the individual states have a vested unique interest in the protection of groundwater as the Federal Government, and as such will continually regulate the process in such a manner that will accommodate their interest. There is no "one size fits all" approach to effective regulation.[398]

However, there are remarkable changes in the methods and technologies deployed in hydraulic fracturing over time as the technique has been increasingly used to develop more challenging formations, resulting in the amount of water and fracturing fluids required also increasing over time. Thus, the question now is whether state oil and gas programmes in the US effectively address issues concerning groundwater protection emanating from the heightened concentration and widened geographical extent of oil and gas resource development that depends on hydraulic fracturing in combination with deep horizontal drilling.[399]

Most oil and gas states in the US have either revised or are considering revisions to their oil and gas laws and regulations as a way of responding to the challenges that arise from these new types and levels of oil and gas production with an overall aim of increasing the protection level of water resources. But this regulatory aspect has been lagging because the extent to which oil and gas agencies coordinate with their water pollution counterparts has been very ineffective. This is so because the regulatory approach adopted by the US government is such that most states have different agencies administering oil and gas programmes and environmental programmes.[400] For example, most of the time the state UIC programmes are regulated by the environmental agencies, while separate oil and gas entities oversee oil and gas exploration and production activities. Alabama is an exception to this phenomenon.[401]

In as much as states have a wide array of regimes in place to manage oil and gas development activities, the policies, regulations and practices relating to ground water protection can be uneven.[402] A review conducted by the GWPC in 2009 revealed that state oil and gas regulations were adequately designed to protect water resources and not groundwater.[403] In virtually all states, it is the same requirements that govern water resource protection covers permitting, well drilling and construction (e.g. casing, cementing, and test pressure requirements), well closure and abandonment, and waste fluid management.[404] For example,

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[397]Further policy positions and information can be found at the iogcc website: http://www.iogcc.org/hydraulicfracturing.

[398]Ibid.

[399]Hydraulic fracturing is used commonly used for gas production in conventional formations as well as unconventional formations. Wyoming, For Example, reported that in 2008, 100% (1,316) of new conventional gas wells were fracture stimulated, many wells with multi-zone stimulations in each well bore, some staged, and some individual fracture stimulations source: Wyoming Oil and Gas Conservation Commission.

[400]See supra Global Insight HIS. (2009) foot note 160 at p.46.

[401]In October 2007, in response to the 2005 Energy policy act, Alabama revised its class II UIC program to once again exclude hydraulic fracturing. The state retains most hydraulic fracturing requirements which it administers under its oil and gas regulatory regime.

[402]Ground Water Protection Council, U.S. Department of Energy, Office of Fossil Energy, National Energy Technology Laboratory, *State Oil and Natural Gas Regulations Designed to Protect Water Resources*, May 2009, p.44.

[403]Ibid.

[404]More details of state rules are included in the detailed regulations reference document accompanying the GWPC Report, *State oil and natural gas regulations designed to protect water resources*, http://www.gwpc.org/elibrary/e_library_list.htm.various states (e.g., co, mt, nd, oh, pa, tx, wy) have since revised their rules.

ten major producing states required the reporting of chemicals used in well treatments, twenty five states required operators to submit well treatment (including fracturing) reports, and twenty two states required operators to cement across groundwater zones.[405] This kind of huge disparity in regulatory requirements leaves room for concern and attention.

While the GWPC found that most states had quite an extensive catalogue of permitting and operating requirements for oil and gas wells, it has also noted that some important provisions in the oil and gas programmes in some states is missing. However, some states had well construction requirements that comprise provisions for cementing above oil and gas producing zones and across groundwater zones. Nevertheless, in terms of requirements for well integrity testing, cement specifications, baseline testing of nearby water well, and other groundwater protection practices, they vary considerably.

5.3 Responsible Factors for an Ineffective Liability Regimes

The dynamic behind the application of liability regimes is that it creates an incentive to invest in risk mitigation and serves as a compensatory mechanism for victims.[406] However, several phenomena reduces the effectiveness of these liability regimes:

The Victim's Apathy is evident in situations when the people exposed to hazards or pollution from an activity do not have the motivation to sue the injurer. This is borne out of the ignorance of the victim regarding the harm, or they assumed that the damage seen has a natural cause or are not just aware of the consequences of an accident on their health or property. These issues deter the victims from going for trial. Thus, this acts to incentivise the injurer from reducing risks by investing in risk reduction through adopting best industry safety practices and so on. Another angle with regard to the victim's apathy is the fact that the possibility of being involved in very lengthy and contentious proceedings with high legal costs, which in most cases is not recoverable, constitutes to dissuade the victim from seeking compensation in the first place.

The Possibility of Injurer becoming Judgment Proof. An operator of a dangerous activity or the manufacturer of a product could become insolvent when his available assets cannot off-set the damage caused. Where this is the case, the inclination of the operator to adhere to risk reduction measures by way of taking care may not be an effective reason because the operator will not typically consider taking measures which ordinarily exceeds his assets.[407]

As a result, most firms in hazardous industries have seen that the ability to be judgment proof as an opportunity not to act right. To achieve this opportunity, operators create separate subsidiaries or spin-offs to house their hazardous activities.[408] For example, the increase of liability for environmental damage caused by shipping accidents further exemplified the opportunity for shipping firms to divide their tanker fleets into multiple single-ship companies.[409] A partial solution is to insist on compulsory insurance or by special public mechanisms of compensation of victims.[410]

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[405]Ibid.

[406]During the network' (2012) workshop, these issues were discussed by several participants, in particular Pierre Bentata and Michael Faure.

[407]From a historical perspective, it is worth noting that prior to the introduction of limited liability rules approximately 200 years ago, investors in a company were fully liable for the default of the company, and their personal assets could be seized by creditors.

[408]Van 'T Veld, K. (2006). Hazardous-industry restructuring to avoid liability for accidents. *International Review of Law and Economics,* 26(3):297–322. Doi: 10.1016/J.Irle.2006.11.003.

[409]Ibid.

[410]Cf. S.3.2 of the U.S Oil Pollution Act of 1990.

Latency. For there to be a cause of action in law, there must be an actual injury. However, in most cases the appearance of symptoms as a result of a person having been exposed to risks may take a long time to manifest physically for the victims to contemplate suing for damages at the time of the incident. Thus, the waiting period weakens the deterrence effect which represents the object of a liability regime. This is compounded by some common law country's legal requirements which have limitation periods that forecloses the right of the victim from commencing trial after the harmful action occurred. This kind of requirements have been overtaken by events in most jurisdictions. Now what is tenable is that the eligibility period begins at the time when the victim knew or should have discovered the manifestation of the injury. What this means is that the time begins to count the moment the plaintiff knew of his predicament caused by the operator's activity in question.

Causal Uncertainty. The nature of liability regimes are designed to serve as deterrence. However, this deterrence effect can only be provoked subject to the ability of the victim to demonstrate a causal connection between the damage and the injurer's activities. This, obviously is very difficult to demonstrate and establish with certainty for many technological systems. For instance, the effects of latency and the widespread use of a specific pollutant may further put stress on the victim to prove causality concerning environmental implications associated with hazardous activities.

5.4 The Symbiotic Nature of Liability Regime and Regulation

When liability regimes and safety regulations complement each other they become more effective in mitigating risks. These complementary roles can fulfil two major goals: Effective regulation and liability regimes have the goal of deterring risk-creators as it provides an incentive for them to take optimal level of care in order to prevent accidents which may lead to harm;[411] and the goal of compensating victims in the event of accidents (which is insuring the consumer).[412]

Now it is pertinent to note that two major factors give credence to liability regimes than the attraction of regulation under the 'social optimum level' perspective: First, the administrative costs of developing and enforcing regulations are generally more than the legal costs involved in managing liability enforcement issues.[413] This is due to the fact that liability applies after the occurrence of an accident, whereas regulation controls all potentially hazardous activities including those for which an accident will not occur.[414] What this means is that while liability operates *ex post*, regulation operates *ex ante.*

Second, the regulator is generally not privy to as good a quality of information as the risk creator in most cases regarding the potential cost of accidents and its prevention. As a result, the risk creator is the one who determines the optimal level of care instead of the regulatory body. Under a liability regime, the threat of being held legally responsible by the courts compels each risk creator to formulate and determine their own optimal level of care within the parameters of their private costs of prevention. Therefore, what forms the focal point in this thesis is based on the suggestion of the economist Shavell. He suggested that the choices observed to be made in the US between liability and regulation are, when broadly viewed,

[411]Hudson, P. (2014). Accident causation models, management and the law. Journal of risk research, 17(6):749–764. doi: 10.1080/13669877.2014.889202.
[412]Ross, L & Shestowsky, D. (2012). Two social psychologists' reflections on situationism and the criminal justice system. In Hanson, J. And Jost, J., (ed.,) Ideology, Psychology, and Law. Oxford University Press.
[413]See supra Yap, N. *et al.,* (2007) foot note 322 at p.17-18.
[414]US Council of Economic Advisers USCEA, (2002). Who pays for tort liability claims? An economic analysis of the U.S. Tort Liability System. *Technical Report*, U.S. Council of Economic Advisers.

socially rational with respect to the optimal level of prevention criterion already described above.[415] It was concluded from Shavell's observation that activities that are heavily regulated, particularly the ones that pose a significant hazard to health and environment, are the ones in which liability regimes demonstrate the most weaknesses.

Whereas activities that create the risk of the typical tort and that are subjected to limited regulation characteristically show elements leaving us with the perception that they ought to be controlled primarily by liability. Since neither option gives the required optimal result independently, this research is in line with the suggestion proposed by Shavell that a combination of both strategies be deployed to mitigate the associated risks with shale gas development and other dangerous industrial activities. According to him, this solution where liability and regulation is used is superior to adopting a one style strategic approach.[416]

It is pertinent to note that, particularly in the US, while the economic perspective has had a significant impact in influencing policy maker's decisions,[417] it does not mean that it is the only normative justification for the existence of liability law. R. Posner wrote concerning the field that he helped to launch that:

> *"Economic analysis of law has grown rapidly, has become the largest, most pervasive interdisciplinary field of legal studies in the history of American law, has palpably influenced the practice of law and judicial decisions, has launched lucrative consulting spin-offs, has spawned courses and text-books in economic analysis of law, has influenced legislation (economic analysts of law played an important role in the deregulation movement), has made it de rigueur for law schools of the first and second ranks to have one or more economists on their faculty, has seeded a number of its practitioners in university administration and the federal judiciary, and has now crossed the Atlantic and begun making rapid benefits in Europe".*[418]

However, Corrective justice theory[419] is the most influential non-economic perspective on tort law, which was originally articulated by Aristotle.[420].The crux of this idea is that in the event that there is a wrongful harm to another, the victim of such harm has a moral right to demand, and the injurer has also a moral right to request, that the victim be returned to his/her status-quo prior to the occurrence of the injury, for example, through the paying of compensation.

The corrective justice theory in tort law represents a system of first-and second-order duties. The first order duties are duties not to injure; they establish norms of conduct. The second order of duties are duties of repair arising from a breach of the first order duty. When one looks at this view, one would come to the conclusion that the rationale behind the formulation of this private tort law idea as being exclusively hinged on justice between individuals, and not with an objective of reaching public-policy goals such as promoting or discouraging certain kinds of conduct.

[415]See supra Shavell, S. (1984) footnote 288.
[416]See supra Shavell, S. (1984) foot note 288, pp. 271–280
[417]Posner, R. A. (1995). The sociology of the sociology of law: a view from economics. European journal of law and Economics, 2(4):265–284. Doi: 10.1007/BF01541067.
[418]Ibid.
[419]See supra World Bank, (2000) foot note 89
[420]Nicomachean Ethics, Book V.

5.5 Regulation as an Environmental Protectionist Tool.

The very essence of an effective regulatory system lies in its ability to enforce compliance among parties within potentially dangerous activities. Societies in recent times have seen the emergence of environmental regulation as a major activity of government. However, there is an increased incentive not to comply with these environment standards as the stringency of regulation increased too.[421] This phenomenon has necessitated the need for adequate enforcement mechanisms. The challenge most of the time is that cost benefit evaluation of a particular piece of regulation which impliedly assumes full compliance is likely to be misleading especially if 'slippage' generically occurs during implementation. More so, if that 'slippage' is substantial.

As a result, regulatory enforcement becomes an aspect in which theory could and should inform policy.[422] The concern is to know the appropriate assumptions to make about the objectives of enforcement agencies. Also, the question of how can politicians best design institutions to prevent the co-optation or capture of enforcement agents? What role is lobbying likely to play in the development of the enforcement area of regulation? The truth in these questions actually go a long way in determining the overall effectiveness of a regulatory structure in place.

Hence, the need for the design of a complementary system that have the capabilities to function on its own, that forces operators within extractive activities to comply without enforcement agents pursuing them. This is what this work aims to achieve by distilling some of the defences put forward by industry proponents. One of those innovative complementary safety approaches proposed by this thesis is the issue of compulsory disclosure of certain operational information within the value chain in the oil and gas sector. This work shall deal with this defence in Chapter VI by vehemently arguing for a compulsory disclosure policy option within the entire industry since the activities of extracting exhaustible resources has nothing mystical about it. Prior to this, it is important that this thesis examines some of the inherent factors that are present in regulatory processes that calls for an alternative complementary approach in order to mitigate risks associated with the activities of extracting exhaustible resources as it occurs in the shale gas industry.

5.6 Inherent Problems of Liability and Regulatory Systems

How do both systems complement each other in achieving the desired effectiveness? When regulation is required, and when is liability appropriate and adequate in certain circumstance instead? Steven Shavell's landmark article[423] where four criteria were examined to base an evaluation of which tool is superior for a particular situation between liability and regulation, shall be used to answer the above questions. These include:

5.6.1 Information Asymmetry

According to this criterion, it is asserted that in situations where, in contrast to private parties, regulators lack knowledge about risky activities, liability is preferred over regulation as a tool for ensuring risk mitigation. This is due to the fact that regulation, without a greater knowledge of information than operators, is probably going to be either lax or too strict in the long run. In contrast, courts are in a better position to ascertain the required level of care and whether

[421] See supra Shavell, S. (1984) foot note 288.
[422] Ibid.
[423] See supra Robert, K. (1994) foot note 319.

the threshold is achieved in a particular case than are regulators across all actual and possible situations.[424]

5.6.2 Ability to Pay Compensation

On the other hand, the incentive to apply liability as the appropriate and adequate option over regulation to change the negative behaviour of operators in risky activities will be defeated in the long run where it is evident that those responsible for such harm(s) cannot not pay in damages to restore victim(s).

5.6.3 Threat of Suit

Here, liability is taken to prove inadequate and inappropriate for ensuring safety in risky activities where those affected are unable to sue either due to the widely dispersed nature of harms involved, or find it difficult to link the harm suffered to the probable creator, or lack the legal standing to sue and do not have what it takes to cater for a class action against the injury caused.

5.6.4 Costs Implication

Nevertheless, there are different aspects of costs associated with both tools. There is the litigation costs for liability systems, on one hand, and there is the administrative as well as the enforcement costs in case of breach of safety standards for regulation on the other hand.[425] While litigation cost implications could be high but only incurred in the event of harm, regulatory cost implications involves the spending of public funds in maintaining regulatory agencies and there are also private compliance costs.[426] This is another criterion where liability is favoured over regulation in risk mitigation for risky activities.

Therefore, Shavell, a Law and Economist scholar, argued that in most real world settings, a mix of liability and regulation is adopted. He said that generally, these criteria seem to influence the choice between liability and regulation because society most often, gets the regulatory or liability decision right.[427]

Having seen the discussions that account for the appropriateness or inadequacy between liability and regulation in mitigating risk in activities, it is imperative that this work provides a discussion as these criteria relate to shale gas development.

5.7 Shale Gas Development: Regulation versus Liability

The aim here is to provide a balanced analysis in the context of the oil and gas sector particularly in the shale gas industry whether liability is appropriate and adequate when compared to regulation in addressing the associated risks. The identified problems just examined are probably true in the oil and gas context because there exist rapid changes in terms of technological advances and the big companies sponsor politician for elections. Just like risks associated with any given activity, private parties are well equipped with better information than the regulators of the most sophisticated state-level agencies.[428] The shale gas industry is not exempted from such problems either. This gives credence for the application of a liability system. Moreover, the decisions of most operators of such activity's decisions are made factoring in liability risks.

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[424]See supra Bechara, A & Damasio, A.R. (2005) foot note 58 pp.60–61.
[425]Ibid at p.63.
[426]Ibid.
[427]See supra Satterfield J. *et al.,* (2008) footnote 189.
[428]Wiseman, H. J. (2013). Risk and response in fracturing policy, 84 U. COLO. L. REV. 729, 734–35, 754–56, 763, 796, 800.

However, regulation may be favoured in other factors. Potential victim(s) do not possess the requisite information like the one available to operators. This is because the business of extracting oil and gas resources occurs deep underground with equipment being controlled and observed by the operator.[429] This makes it quite difficult for courts to conclude whether operators exercised the level of care required.[430]

Another issue which makes regulation more advantageous in addressing risks than a liability system is that major oil and gas firms have small independent companies just for the sole purpose of avoiding stringent liability penalties. These firms lack adequate resources to cover large awards in damages.[431]

It is perhaps due to the nature of oil and gas activities that can lead to significant but widely spread harms that makes it a strong factor in favour of regulation than a liability system.[432] This is because the latter would be an ineffective and impracticable approach in tackling problems such as fugitive methane emissions, or contamination of rivers and streams with flowback fluids. This is not to say that this is unique to oil and gas drilling, but rather the majority of environmental regulations can hinge on the inability of the traditional liability system to address widespread dispersed harms associated with industrial activity as the main reason for playing down on liability systems.

To determine whether regulation or liability is superior in cost terms for shale gas risks or any others is quite difficult. Having struggled with this issue, Shavell formulated some general principles in his 1984 article to determine which option is superior in terms of cost. He concluded by saying that, putting both options on a scale, liability is likely to be less costly because governments are not independent arbiters in the market of regulation, but are interested rationally-self-interested.[433]

This is likely to be true if the case is a small-scale event that required a one-off cost. There is almost certainly a different cost issue when the resultant harms are dispersed because to commence and conclude class actions are seriously complex. Moreover, in commencing class actions lawsuits, costs of a pure liability approach may be very expensive.[434] In fact, the threat of suit which is the third criterion in Shavell's formulated principle could be seen as a special case of his cost pillar.

Due to the high cost of legal action and collective action problems or procedural barriers that courts erect to protect against difficult-to-resolve suits, plaintiffs find it difficult to sue.[435] In other cases, the lack of a threat to sue might emanate from information asymmetries. When plaintiffs do not know who for certain is responsible for the contamination of their water, for example, they are unable to sue. However, where private parties have access to relevant information and instances of harm are relatively scarce compared to the level of activity,

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[429]Jimerson, C. B & Moss, M. F. (2013). *Top 5 Issues in today's Hydraulic Fracturing Litigation*. P.A, http://www.jimersoncobb.com/blawg /2013/12/top-5-issues-in-todays-hydraulic-fracturinglitigation/*archived at* http://perma .cc/nn87-95wn.

[430]Ibid.

[431]Forbes, S.M. (2013). The United States and China Moving toward responsible shale gas development, Brookings Institute [Online] at http://www.brookings.edu//media/events/2014/06%20china%20clean /20energy/uschina%20moving%toward%responsible%shale%gas20development-sforbes (Accessed on 06/04?2018).

[432]Urbina, I. (2011). Regulation lax as gas wells' tainted water hits rivers, *New York Time* http://www.nytimes.com/2011/02/27/us/27gas.html?pagewanted=all&_r=0, *archived at* http://perma.cc/4zat-tb3r

[433]See supra Osborn, S.G *et al.,* (2011) footnote 186 at p.63, 65.

[434]Menell, P. S. (1991). The limitations of legal Institutions for addressing environmental risks, 5 J*ournal of Economic Perspective.* 93, 93–94, 101.

[435]See supra Shavell, S. (1984) footnote 228.

liability might be significantly less costly than detailed regulation. Truck accidents and surface damage to landowners' property are a good example to illustrate the less costly nature of liability than regulation as stated above. Such damage and accidents are generally negotiated within the shadow of the tort system.

Therefore, Shavell's principles that provide illumination regarding the division of labour, as it were, between liability and regulation, seem to be applicable in the oil and gas context as it was asserted that it does generally.[436] However, this does not in any way infer that some activities presently regulated might not be better handled through liability, or that additional regulation is not required because the current liability system is adequate.

Nevertheless, this thesis cannot delve into the dynamics of either claim as far more evidence is needed to do so, nor is it to say that this division of regulatory labour exists by design. Regulation is imposed as a substitute for liability systems when it is seen that it is inadequate in addressing a risk – usually in situations poorly suited to liability under Shavell's criteria – not *de novo* formulation of regulatory regime anchored on a theoretical framework. Implicitly, a liability systems great virtue is that it is the default, meaning new activities and technologies are governed by it even if these technologies outpace top-down regulatory approaches.

Now having seen the principles formulated by Shavell in his article regarding the issue of regulation versus liability, and having carried out a brief discussion to determine whether these criteria hold in the oil and gas context, it is now imperative to also analyse certain factors based on the principles formulated in the Restatement (Second) of Torts in order to illustrate whether or not shale gas fracking qualifies as an abnormally dangerous activity sufficient to warrant stringent liability systems as a way of complementing the existing regulatory approach that the technology of fracking has outpaced on the one hand. On the other hand, it gives justification for the necessary policy options which this thesis seeks to provide to address the gaps between the environmental protection tools for reducing risks.

5.8 Arguments Why Fracking's Water Contamination Risks should be a Strict Liability Claim.

This will now set out the argument of whether fracking should be subject to stricter liability as abnormally dangerous activity or, alternatively, whether a fault-based standard with a *res ipsa loquitur* rule is more appropriate. The theories of res ipsa loquitor and the fault-based rule for determining liability shall be discussed here against the backdrop of the factors as contained in section 520 of the Restatement. This analysis shall attempt to define what these theories mean in line with the requirement of section 520.

One of the first questions that needs attention are factors (a) and (b) that talk about the degree of harm and the degree of risk that should result in harm to be majorly sufficient to subject fracking or any activity to strict liability as an abnormally dangerous one. A point must be mentioned here that there is a clear distinction between an abnormal substance and an abnormal activity. This is important because an operator of an abnormal substance is not subject to a strict liability rule merely because they engage in such with a clear proof of fault that resulted in harm. Rather what this thesis is about in this section is to bring out through legal analogies and operation of the activity whether it has residual risks that cannot be avoided by due care.

[436] *See* supra Bechara, A & Damasio, A.R. (2005) foot note 58 pp.274-76.

5.8.1 Factors (a) & (b) Great harm and high degree of risk

The question at this juncture is what is great harm and the degree of risk needed to categorise an activity as abnormally dangerous? Fracking's activity shall be weighed against these two factors (a) and (b) requirements in section 520. To answer this question and to make the comparative analysis of the other factors in section 520, the work shall rely on certain vital ingredients to make this comparison.

The transgenerational harm factor, the frequency of risk of harm factor and the availability of other alternative fracking technique factors shall be used to explain the factors in section 520 to show that fracking as an activity should be subject to strict liability rule as well as stricter policy interventionist options.

The term transgenerational harm deployed by this thesis to explain what great harm should be was borrowed from the tenets of inter-generational equity principles under international law. The inter-generational equity principle is defined as conserving the diversity of the natural and cultural resources base**.** The conservation of quality implie**s** the need to leave the planet no worse off than received**.** Conservation of access also implies the equitable access to the use and benefits of the legacy.[437] Taking a cue from these definitions, harm that is transgenerational in nature is harm that impacts not only the host victim but extends to future generations. Therefore, where an activity presents such a harm and degree of risk, then it is justifiable to categorise that activity as an activity with great harm and high degree of risk. Put another way, a true understanding of what great harm and high degree of risk of harm is all about is a situation where future generations are affected by an impact of yesterday.

Now the question is whether fracking activities portray a transgenerational harm and high degree of risk in the event of accidents. To answer this question, it is important to explore some examples showing this transgenerational impact of shale gas fracking. For example, a You-tube video captioned "Fracking Hell: The Untold Story" illustrated some of these statements that reflected the transgenerational effects. One of the interviewers stated: "*Water is a commodity and once you lose it, it is gone*".[438]

From this comment, it is evident that once this happens, there is never opportunity for remediation of the contaminated water resource. A second example that shows this transgenerational impact is the fact that there are few available underground disposal facilities to accommodate the high volume of fracking fluids originating from frack sites.[439] Therefore, where there are no facilities to accommodate these fluids, the only option is to dispose of them in major rivers across the states thereby contaminating the water for life. These cases reveal that this activity presents a great harm effect.[440]

The other limb is whether the risk of accidents that emanate from fracking is high. The answer is also in the affirmative. For this, the frequency factor theory shall be used to buttress the argument for strict liability. As the name implies, it determines the rate of incidents. Where the number of accidents of an activity that has an intergenerational impact is high, then that activity should be classified as an activity with great harm in accordance with section *520* of the *Restatement (Second) of Tort Act*. The following review analysing litigation involving

[437]Weiss, E. B. (1989). In Fairness to Future Generations: International Law, Common Patrimony, and Intergenerational Equity (Transnational, 1989).
[438]Proff Ingrafae video on fracking and the consequences.
[439]Nicholson, B. R. (2014). Analysis of litigation involving shale &hydraulic fracturing, (compiled by the Norton Fulbright law firm). pp 1-26.
[440]Ibid.

shale and hydraulic fracturing compiled by Barclay R. Nicholas in June 2014 will be used here to prove the assertion that the rate of accidents for fracking is quite frequent.

For example, fracking has recorded accidents that affect water contamination, air pollution, and loss of victim's property and wrongful disposal of frack fluids in contravention of the regulatory requirement claims.[441] In fact, from 2009 to 2012, according to the analysis written by Nicholas, there has been over thirty cases filed by plaintiffs in various US courts seeking for damages and remediation.[442] In fact, courts and states and local governments in Colorado, New Mexico, Alabama, Ohio and Pennsylvania have recorded over one thousand (1,000 issues of contamination from hydraulic fracking).[443] From the formulated transgenerational harm factor and the frequency rate factor, this corroborates the fulfilment of the first two factors of section *520*, namely the classification of fracking as an abnormally dangerous activity.

Likewise, it seems unfair for a court to find that fracking does not pose a high degree of risk because scientific evidence presently at least has concluded that it does not. The right thing for a court to look is the preponderance of evidence reported in the media and the multiple cases filed against fracking operations by plaintiffs in the US; it is this that should now matter while reaching conclusion.

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[441]See the cited cases on the issues raised that show the frequency of frack accidents and claims…Zimmermann V. Atlas America, LLC, No. 2009-7564 (Pa. Ct. Com. Pl., Sept. 21, 2009). See also, Fiorentino V. Cabot Oil & Gas Corp. And Gas Search Drilling Services Corp., No. 3:09-Cv-02284 (M.D. Pa., Nov. 19, 2009) (Also known as Ely V. Cabot Oil & Corp., et al.). See also., Heinkel-Wolfe V. Williams Production Co., LLC; Mockingbird Pipeline, LP, XTO Energy, Inc., Gulftex Operating, Inc., Trio Consulting & Mgmt., LLC, and Enexco Inc., No. 2010-40355-362 (362nd Dist. Court, Denton County, Texas, Nov. 3, 2010). See also., Mitchell V. Encana Oil & Gas (USA), Incorporation; Chesapeake Operating, Inc.; Chesapeake Exploration, LLC, No. 3:10-Cv-02555 (N.D. Tex., Dec. 15, 2010). See also., Teel V. Chesapeake Appalachia, LLC, No. 5:11-Cv-00005-FPS (N.D. W. Va. January 6, 2011) (Originally filed in the circuit Court of Wetzel County, W. Va., Case No. 10-C-94DH, Nov.30, 2010) See also., Ramsey, *et al.,* V. Desoto Gathering Company, LLC, Case No. 23CV-14-258, in the circuit Court of Faulkner county, Arkansas for the 20th judicial district (April 24, 2014), See also., Magers, Et Ux V. Chesapeake Appalachia, L.L.C., CNX Gas Company, L.L.C., And Columbia Gas Transmission, L.L.C., No. 5:12-Cv-00049-FPS (N.D. W.Va., Sept. 4, 2012). See also, Hill, *et al.,* V. Southwestern Energy Company, *et al.,* No. 4:12-Cv-00500 (E.D. Ark., Aug. 10, 2012). See also, Butts, *et al.,* V. Southwestern Energy Production Company, No. 3:12-Cv-01330 (M.D. Pa. July 10, 2012). See also., Haney, et al V. Range Resources Appalachia, LLC., *et al.,* No. 2012-3534 (Pa. Ct. Com. Pl., May 25, 2012). See also., Roth V. Cabot Oil and Gas Corporation and Gas Search Drilling Services Corporation, No. 3:12-Cv-00898 (M.D. Pa. May 14, 2012) (Originally filed in the court of Common pleas of Susquehanna County, Pa., Case No. 2012-324, March 19, 2012). See also., Manning V. WPX Energy Inc. and the Williams Companies, Inc., et al., No. 3:12-Cv-00646 (M.D. Pa. April 9, 2012). See also, Mangan V. Landmark 4, LLC, No. 1:12-Cv-00613 (N.D. Ohio, March 12, 2012). See also. Beck V. Conocophillips Company, No. 2011-484 (Dist. Ct. Panola County Tex., Dec. 1, 2011). See also, Strong V. Conocophillips Company, No. 2011-487 (Dist. Ct. Panola County Tex., Dec. 2, 2011). Scoggin V. Cudd Pumping Services, Inc., RPC Inc., and Cudd Energy Services, No. 4:11-Cv-00678-JMM (E.D. Ark. Sept. 12, 2011). See also., Becka V. Antero Resources A/K/A Antero Resources Appalachain [Sic] Corp. S/K/A Antero Resources Appalacia [Sic], LLC; No. 2:11-Cv-01040 (W.D. Pa. August 12, 2011) (Originally filed in the Court of Common pleas of Washington County, Pa., Case No. 2011-4812, July 18, 2011). See also, Lipsky V. Durant, Carter, Coleman LLC, Silveradoo on the Brazos Development Company #1 Ltd; Jerry V. Durant James T. Coleman, estate of Preston carter, Range Production Company, and Range Resources Corp., Cause No. CV11-0798 (Parker County Dist. Ct., June 20, 2011).

[442]Nicholson, B. R. (2014). Analysis of litigation involving shale & hydraulic fracturing, (compiled by the Norton Fulbright law firm). pp 1-26.

[443]Lustgarten, A. (2008). Buried secrets: Is natural gas drilling endangering U.S. water supplies*? Pro Publica* [Online] http://www.propublica.org/article/buriedsecrets-is-natural-gas-drilling-endangering-us-water-supplies-1113. In fact, burning gas, used primarily to heat homes and make electricity, emits twenty-three percent less carbon dioxide than burning oil. *Id*. furthermore, gas is the country's second-largest domestic energy resource after coal.

5.8.2 Factor (c) Inappropriateness of the Activity to its Location[444]

The next factor to consider in section *520* of the *Second Restatement Act* is factor (c) the inappropriateness of the activity to its location, to ascertain whether fracking activity qualifies as an abnormally dangerous activity. The intention of the craftsmen of these factors in the Restatement Act with regard to factor (c) is to determine whether an activity constitutes a natural use of the land where it is conducted.[445] The wisdom for which the authors considered factors (a) and (b) with factor (c) is that some activities present great harm and high degree of risk when conducted in certain locations.[446] For example, citing a large water reservoir in open country is not abnormally dangerous, but the same reservoir on a bluff above a large city is.

In plain terms, the authors of this factor conclude that it is very difficult for courts to determine the degree of risk of great harm of an activity in isolation without taking into consideration the risk in the context of its location. In the opinion of this thesis, this is only a limited interpretation of the true tenets of factor (c). Confining the inappropriateness of an activity to only the location it is being carried out is altogether misleading.

At this point it is important to consider the catch phrase in factor (c). The word "inappropriate" needs to be examined in its independent state. What makes a thing inappropriate is not limited to the location where it is being carried out. Rather it goes beyond that. The argument is as follows: an activity can also be inappropriate when a particular form of technique is preferred amidst alternatives with less disadvantages. This brings us to another factor formulated by the author of this thesis which is meant to shed more light to the reader to prove and extend the meaning of an inappropriate activity. A factor called the *availability level of other forms of technology* shall be explained to show that the slick water fracking technique is inappropriate when one considers other forms of fluid based hydraulic fracking techniques.

Regarding fracking technology, the question is: are there other forms available that the industry players could have opted for aside the slick water hydraulic fracking technique? The answer is in the affirmative. The next ideal question that should follow is whether other alternatives are safer to operate in terms of health and the environment. The answer is also in the affirmative. For detailed examination of the various forms of fluid based hydraulic fracking technologies, their advantages and disadvantages as well as the rationale behind the industry choice is discussed sub section 3.6 of Chapter III.

Therefore, fracking activity could become inappropriate in terms of its technique where other safer alternatives are available, yet the industry chose the slick water HVHF technique. It leaves one with no other option but to conclude that there is certainly going to be great harm and risk of harm as an inappropriate activity due to the choice of technique adopted though it is within the natural use of the land where it is conducted.

Moreover, this thesis also argues that, considering the rate of aquifer and groundwater contamination, it is highly true that this fracking technique is inappropriate in its location with regards to factor (c). Taking a cue from the *Harthman v. Texaco Incorporation* case,[447] where the court held that the storage of gasoline underground for fuel station purposes was abnormally dangerous due to the location of the storage tank: a fresh water aquifer that served

[444] *See* Restatement (Second) of Torts § 520 Cmt. G.
[445] § 520 Cmt. J ("This [factor] is sometimes expressed, particularly in the English cases, by saying there is strict liability for a 'non-natural' use of the defendant's land.").
[446] See Section 520 Cmt.G.
[447] Harthman V. Texas, Inc., 846 F. Supp. 1243, 1270 (D.V.I. 1993).

as a community's primary source of drinking water was situated directly beneath the fuel station's tanks.[448]

By this precarious location of the storage tanks, it automatically increased the likelihood of harm, and established the possibility for great and imminent harm.[449] The question is whether fracking in its present operation is appropriate considering the series of contamination claims filed in courts. All drilling activities in fracking take place close to fresh water aquifers or above groundwater reservoirs of a shale play, along similar lines to Harthman case.[450]

Since the Harthman case failed factor (c) inappropriateness of the activity to its location, fracking should fail too. In fact, based on this case, the common thread running through these cases is how the location of an activity affects its riskiness. Under this view, there could not have been any appropriate location for fracking within areas densely populated.[451]

In summation, based on the transgenerational harm factor as well as the frequency rate factor formulated by this thesis to explain what great harm and high degree of risk related to fracking should be, it is imperative to say that factors (a) and (b) weigh in favour of fracking qualifying as abnormally dangerous because most groundwater and fresh water contamination issues are irredeemable and the rate at which these contaminations take place is quite alarming. Second, factor (c) definitely indicts fracking strictly liable in the choice of technique and for the fact that it occurs virtually always around water resources belonging to an individual or a community.[452]

5.8.3 Factor (d) Risk Not Eliminated by Reasonable Care

To apply factor (c) to fracking, this sub section shall examine its operations by connecting it to the question of whether the risks are unavoidable even though the actor had taken all reasonable precautions in advance and had exercised all reasonable care in his operations, so as not to be negligent.[453]

According to Boston, this is the most germane of the section *520* factors.[454] Implicitly, Boston stated that in application, courts hold an activity as abnormally dangerous only at the instance where the residual risk is high or abnormal.[455] In sum, this factor examines whether accidents are avoidable or not. Accidents are avoidable by the exercise of reasonable care.

However, to assume that accidents are avoidable in all human activities is a complete misunderstanding of the intent of factor (d). Each activity must be examined on its own merit and the issues it presents. Therefore, if factor (d) is out-come determinative, it then means that risks in some activities are completely unavoidable.

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[448]Ibid at p.1269.
[449]Ibid at 1270.
[450]Aarthur J. D *et al.,* (2014). Hydraulic fracturing considerations for natural gas wells of the Marcellus shale p.2 Available at [Online] http://www.dec.ny.gov/docs/materials_minerals_pdf/gwpcmarcellus.pdf (Accessed on 12/06/2017).
[451]Ibid at p.2 (it is also true that coalbed methane fracking occurs at much shallower depths and often directly into an underground drinking water source. EPA USDW Evaluation draft 2011.
[452]Zimmermann, V. Atlas America, *LLC*, No. 2009-7564 (Pa. Ct. Com. Pl., Sept. 21, 2009. (This case shows where a class action was filed against the defendant for contaminating their water aquifer symbolizing that fracking was inappropriately located as it affected a population).
[453]Restatement (Second) of Torts § 520 Cmt. H (1977).
[454]See supra Sakar, R. (2008) footnote 318 at p.649 ("[H]ow the 'activity' being evaluated is described by the court will greatly influence the outcome of the analysis under Section 520.").
[455]New Meadows Holding Co. V. Wash. Water Power Co., 687 P.2d 212, 216 (Wash. 1984) (En Banc) (finding that reasonable care could reduce the risk associated with a natural gas line to prevent the application of strict liability).

Having said that, what one should be considering is whether fracking accidents are avoidable or not. To understand factor (d) further it is important to know how courts define the activity is the threshold question in this analysis.[456] Courts may decide to look at the activity in a general sense and once that is the case, the court is more likely to find that reasonable care can eliminate the activity's high risk. Whereas, if they describe an activity in a more specific sense, the more likely it is to find that reasonable care cannot eliminate the activity's high risk. The former definition of an activity is in its benign, pre-injury-causing condition to avoid strict liability.[457] It is important to remember here that factor (d) is outcome determinative in strict liability issues. If this is the case, why then would courts define the activity in its pre-injury causing condition to avoid applying strict liability.[458] The right thing to do is to define the activity by the harm it has already caused since the totality of factor (d) is outcome determinative. Take for instance, the New Jersey Supreme Court case *State Department of Environmental Protection v. Ventron Corp.*[459] Ventron court, in its application of factor (d) found only "with respect to the ability to eliminate the risks involved in disposing of hazardous wastes by the exercise of reasonable care, no safe way exists to dispose of mercury by simply dumping it on land or into water."[460]

Whereas, in *Erbrich Products Co. v. Wills,* the plaintiffs sued a liquid bleach manufacturer under a theory of strict liability for abnormally dangerous activity for accidentally releasing a harmful amount of chlorine gas into the surrounding outside air. Assuming the plaintiffs in both cases urged the courts to examine the dangerous characteristics of chlorine gas as an issue. The *Ventron* court perhaps might have framed the issue as whether the release of chlorine gas into the air was abnormally dangerous. On the other hand, the *Erbrich* court might have framed the issue as "whether the manufacture of chlorine bleach constitutes an ultra-hazardous or abnormally dangerous activity."[461]

In both cases the subject of chlorine gas and chlorine bleach are all part of the activity. One cannot divorce the other to get a true characteristics and nature of an activity. Just like natural gas being flammable and as poisonous as chlorine gas and chlorine bleach in their characteristics, but the activities of extracting and manufacturing, respectively, might not be abnormally dangerous.

The argument is therefore as follows: once the object of any activity has a dangerous characteristic then it reflects a great harm and high degree of risk. Put another way, it is dangerous in principle. Such activity becomes finally abnormally dangerous upon the existence of an outcome of an incident. It suffices at this juncture to assert that the existence of an abnormally dangerous object (natural gas, chlorine gas and chlorine bleach) automatically presents a situation where risks cannot be eliminated even though the actor has taken all reasonable precautions in advance and has exercised all reasonable care in his operation. Thus, it becomes a question of 'when' and not 'likely' harm occurring.

In contrast, the *Erbrich* court, after analysing the case held that due care could have eliminated the risks of chlorine pollution during the defendant's manufacturing activities. What the court meant was that it was an avoidable accident. The conclusion is this: the shale gas extraction process is flawed with multi claims of pollutions issues since the commencement of this activity. The outcome of accidents is with great harm, the risk of harm is high and the

[456]See supra Marcovici, M. (2013) footnote 353.
[457]Ibid at 656.
[458]Ibid.
[459]State Department of Environmental Protection v. Ventron Corp. 468 A.2d 150 (N.J. 1983).
[460]Ibid at p.860.
[461]Ibid at p.861.

inappropriateness of citing a shale well is visible and these risks cannot be eliminated by reasonable care because no one can say with certainty what takes place underground during drilling process. More so, the presence of dangerous substances in an activity already creates a high and abnormal residual risk factor which cannot be eliminated even with the utmost reasonable care package of the relevant actor.[462]

5.8.4 Factor (e) Extent to which the Activity is not a Matter of Common Usage

Indeed, it is quite difficult to examine factors (d) which talks about the inability of risks being eliminated by reasonable care (e) which talks about matter of common usage requirement and factor (f) which talks about the extent to which the activity's value to the community is outweighed by its dangerous attributes. Factor (d) in its interpretation tends to have a broad definition which could diminish its usefulness to courts.

According to factor 'e', an activity is a matter of common usage "if it is customarily carried on by the great mass of mankind or by many people in the community".[463] From this understanding, common usage does not include where an activity's action affects a great mass of mankind. Rather it is the extent to which others in the same industry or vicinity apply the said same activity. This was exemplified in the case of *Sprankle v. Bower Amonia &Chemical Co*.[464] In this case the court decided that the extent to which fertiliser and hydrous ammonia was applied and stored in large quantities in a wide variety of agricultural, industrial and commercial manners fulfilled the common usage requirement in factor (e).[465] Also, the fact that an activity was carried out in an established field or community where that activity is well known by a majority of people within that community cannot pass for the common usage criterion. This misconception of what the concept of common usage is was revealed in the case of *Williams v. Amoco Production Co.*[466] Here, the court held that the drilling and operation of natural gas wells were a matter of common usage because it occurred in an established gas field where other similar activities were common.

This decision could hold true only to the extent that the drilling and operation of natural gas wells was a matter of common usage but not because it occurred in an established gas field where other similar activities were common. The point is this: to ascertain whether indeed the slick water hydraulic fracking passes the test of common usage requirement in line with factor 'e', it must be operational in virtually all countries of the world that have shale gas resources.[467] To use one established gas field in a country or two as a yardstick to establish common usage is altogether restrictive because one country and one established gas field does not represent the 'great mass of mankind' ingredient in the interpretation of the common usage criterion. Present, shale gas extraction through slick water hydraulic fracking is being used in the USA and few presence in China and forestall because of environmental issues like earthquakes traced to shale gas fracking. However, other regions like the UK, Poland, Algeria and Bulgaria still attempting to overcome the hurdles involved.[468]

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[462]See New Meadows Holding Co. V. Wash. supra footnote 455 (finding that once an activity has a residual risk factor, reasonable care is incapable of eliminating the occurrence of great harm to prevent the application of strict liability).
[463]See Restatement (Second) of torts § 520 Cmt. I (1977).
[464]Sprankle v. Bower Amonia &Chemical Co. 824 F.2d 409, 415–16 (5th Cir. 1987).
[465]Ibid at p.416 (quoting Restatement (second) of torts § 520(D) (1977)).
[466]734 P.2d at 1123.
[467]For example, of countries that operate fracking as a technology for the extraction of oil and gas from shale formations…See U.S, Canada and Europe queuing to kick off although it has been attempted in some part in Britain.
[468]See supra Schmitt, R. (1994) foot note 356.

5.8.5 Factor (f): Extent to which the Activity's Value to the Community is Outweighs its Dangerous Attributes.

This factor is malign in that it is irrelevant in determining whether a risk should be allocated to the defendant because of the activity's dangerous nature. Due to this irrelevance, other writers and courts often do not determine this factor in their effort to know whether an activity is abnormally dangerous.[469]

A critical look at this factor suggests that Texas and Oklahoma might not view oil and gas wells as abnormally dangerous, but the same oil and gas wells will turn out abnormally dangerous due to the reduced economic reliance attached to the petroleum industry in some states and countries that do not have these resources at all.[470]

However, it is evident that an activity's value to the community has been interpreted by courts to mean the potential to create jobs.[471] This assumption appears subjective because the potential jobs in which the oil and gas industry may give to the people is something that only last during the lifespan of the well or the fracking process.

Most oil and gas workers are often retrenched at the early stages of the operations. For example, after drilling, close to 20% of the work forces' contracts end for the reason that they are just temporal.[472] Also, experts from other work fields are transferred to do the same fracking jobs in new fields within the same country or from another country. These job figures in the true sense of it appears to be only a fraction as not all workers have permanent contracts in the true sense of it.

5.9 Summary

Activities that cause great harm of environmental pollution and health risks should be held to be unavoidable as a matter of law. Although fracking generally has been a common usage in the industry, but slick water hydraulic fracking technique is not a common usage yet in 'oil and gas industry of the world.' No wonder the EPA till now has not been able to come up with definitive proof to link water pollution to shale gas activities.[473] Therefore, as the cases discussed here showed, an activity that causes frequent accidents that in most cases results in irreparable damage should be categorised as abnormally dangerous. The application of due care will not be able to eliminate such activities potential for harm. It will indeed be inequitable if such an enterprise is not held strictly liable as well as incorporating other policy options meant to reduce risks because empirical evidence reveals that it is not safe to conduct such an activity.

Moreover, based on the empirical evidence fracking, does not qualify as an activity within the interpretation of what common use of land is. Nevertheless, it has been established by a

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[469]For example, of countries that operate fracking as a technology for the extraction of oil and gas from shale formations…See U.S, Canada and Europe queuing to kick off although it has been attempted in some part in Britain.

[470]Restatement (Second) of Torts § 520 Cmt. K (1977).

[471]See supra Zikargae, M. H. (2018) footnote 330, p.629 (Arguing "that factor (f) is not [appropriate for inclusion in the adjudicatory calculus]; and that, on examination, the decisions in the last thirty years support precisely that conclusion").

[472]Shawver, S. (2001). Perspectives: Expansion of oil, gas industry could mean more jobs, *Marietta Times* [Online] http://www.mariettatimes.com/page/content.detail/id/538695/perspectives%e2%80%94expansion-of-oil%e2%80%94gas-industry-could-mean-more-jobs.html?nav=5002. (Accessed on 12/06/2017).

[473]U.S. Environmental. Protection. Agency, evaluation of impacts to underground sources of drinking water by hydraulic fracturing of coalbed methane reservoirs 4-2 (2004) [hereinafter EPA usdw evaluation 2004].

number of courts in the US that extracting oil and gas from gas lands is natural. It is entirely wrong to assume that this is a matter of common usage because that term is defined by the activity's applicability level in the countries across the world and not based on the singular vicinity of an established field. Finally, fracking's valuableness does not depend on the number of jobs it created because those jobs are short lived and the same set of workers are being recycled to execute future fracking jobs. This cannot stand as a justifiable bases for offsetting the activity's residual risks.

Therefore, the factors in section 520 vehemently weigh against fracking as an abnormally dangerous activity. This conclusion does not in any way suggest that the risks arising from fracking activities are unique to fracking alone, but the frequency with which these accidents occur in the case of fracking is alarming.[474] For example, to identify potential scenarios of concern regarding human health risks surrounding the natural gas drilling industry a survey of industry workers and regulators was developed and implemented to quantify the frequency of failure incidents and near-miss accidents at the wellhead site. The goal of the survey is to better understand scenarios of concern for human health risks as a result of operational failure incidents and regulatory violations during natural gas drilling in the Marcellus shale region in the state of Pennsylvania. Thus, an elicitation of health perceptions regarding unconventional shale gas development in the Marcellus region found that 22% of the 72 respondents perceived unconventional drilling as a health concern, while 42% attributed health symptoms to environmental factors, the most frequently selected of which was unconventional drilling activities.[475]

Also, to further illustrate to the reader the frequency level of shale gas incidents to justify for a strict liability regime, a study conducted by Vengosh et al. in 2014[476] regarding contamination risks to water sources. The study identified four scenarios where these risks can occur from shale gas extraction: stray gas leaking into shallow aquifers, surface water contamination from spills and leaks, soil and river sediment contamination from wastewater, and the overuse of freshwater for hydraulic fracturing.[477] These four scenarios is only related to water contamination risk. This accordingly, resonates a high frequency level of risk resulting in water contamination issues. This is why this thesis proposed for a '*risk/segment based strict liability rule.'* By this, this thesis means that where a particular risk relating to an activity has an increased frequency in its occurrence, that risk should be subject to a strict liability regime under the risk based strict liability rule.

[474]See supra Osborn, S.G *et al.,* (2011) foot note 186. (Illustrating the statistics of fracking contaminating water and other violations regarding regulatory requirements).
[475]Saberi, P. *et al., (*2014). Field survey of health perception and complaints of Pennsylvania residents in the Marcellus Shale region. *J Int J Environ Res Public Health. 2014 June; 11(6):6517-27.*
[476]Vengosh, A. *et al.,* (2014). A critical review of the risks to water resources from unconventional shale gas development and hydraulic fracturing in the United States, *Environmental Science Technology*, Volume 48, Issue 15, pp. 8334-48.
[477]Ibid.

Chapter 6

6. Why Hydraulic Fracking Water Contamination Risks should be Subject to Strict Liability Claim: Discourse

The water contamination issue has taken centre stage of discussions in energy issues and is the fundamental criticism that shale gas fracking has had to and continues to face. Some have argued that we cannot continue to contaminate water resources considering its scarcity and its relevance to survival.[478] To this end, there is a need to tackle this challenge through effective means. On way to do that is through a strict environmental regulatory reform. Consequently, this chapter aims to examine arguments that justify the application of a strict liability regime for water contamination claims. It is the argument of this thesis that if this is entrenched in the legal system that governs shale gas extraction activity, it would go a long way in forcing operators to adhere to best practices such as segregating drilling and exploitation in densely populated areas.

Also, it will transfer the burden of proof to the party that is best equipped to prove otherwise. In this context, the operator may be the only one that knows the technical aspects of fracking. Thus, they will be in a better position to prove their innocence once the duty to prove has been placed upon them by law. This is based upon the premise that the scientific world advances faster than the regulatory agencies can keep abreast of technological developments.

Last, it would further reduce the probability level for this risks to occur during shale gas extractive activities. This does not in any way suggest that water contamination does not happen in conventional oil and gas extractive activities. Rather, when compared with the level of occurrence, the former seem to have a frequency level that is beyond the socially optimal level of risk. Moreover, this is further complicated by the various avenues in which this contamination might happen as examined in Chapter III of this thesis. Roughly, there are about four possible ways fracking fluid can contaminate water aquifers and groundwater.

6.1 Introduction

The rush for natural gas coupled with technical advances in drilling has dramatically increased the number of hydraulic fracking projects, especially in the US. Volatility in energy prices and the need for domestic, relatively clean energy sources have made natural gas become extremely attractive as an energy source.[479] Although in the US large quantities of conventional deposits are still being produced they are overall in decline.[480] In recent years, the hydraulic fracking technique has provided an opportunity to fill the gap in the decline of conventional energy sources by opening access to unconventional deposits, thereby geographically expanding the "gasland" and unlocking, at least in some regions, a "Saudi Arabia of Natural Gas".[481] This expansion to other jurisdictions is likely to continue from all

[478]This is in accordance with the Millennium Development Goal MDG objectives and the Sustainable Development goal objective. It has being stated that nations of the world should make adequate safe guard measures to curb the water crisis in the world.

[479]U.S. Energy Information. Administration Department of Energy, "Energy price impacts on the U.S. economy 6 (2001), *available at* http://www.eia.doe.gov/oiaf/economy/energy_price.pdf; (Accessed on 14/06/2017)

[480]Wiseman, H. (2010). Regulatory adaptation in fractured Appalachia, *Villanova. Environmental Law Journal* Volume 21, pp.229, 229–30 (2010).

[481]Chesapeake Energy, Hydraulic Fracturing: Fact Sheet 1 (2011), a*vailable a t*http://www.chk.com/media/educational-library/fact sheets/corporate/hydraulic_fracturing_fact_sheet.pdf; EPA, science in action: hydraulic fracturing research study 1 (2010), *available at* http://www.epa.gov/safewater/uic/pdfs/hfresearchstudyfs.pdf. (Accessed on 21/06/2018).

indications, with predictions indicating that by 2020, twenty percent of the world's natural gas will come from hydraulic fracking.[482]

However, others are worried by the break neck pace of expansion, especially because of the environmental and health risks of hydraulic fracking, dire in the worst case and unknown at best.[483] Chief among the threats that fracking presents is the environmental and health concerns related to clean water. In both developed and developing societies, water and energy are necessary in large quantities for them to continue to function and thrive. A Supreme Court justice in Texas recently wrote that while water, not oil, is the lifeblood of Texas, "oil and gas are its muscle."[484] Likewise, the world can survive without oil and gas but cannot survive without water because nature has played it out that water can flow from various sources such as rock top and natural fountains without the assistance of any technology. Whereas, oil and gas need the assistance of sophisticated technologies to discover and extract them.

Be that as it may seem, the world will have to make some difficult and serious decisions about the world's water and energy supplies, especially about hydraulic fracturing.[485] Hence, the role of this Chapter is to attempt to analyse the current status of the strict liability doctrine and pertinent cases. It will finally argue for a likelihood of successfully applying a strict liability as one of the framework policy option to the pending agitations across the globe as a cause of action for water contamination.

More importantly there ought to be a balance between the dividends an activity promises and the weight of environmental and health concerns surrounding that activity. This Chapter therefore concludes under this context that strict liability is legally appropriate and socially beneficial following complaints from numerous people living near hydraulic fracking wells alleging that the process is responsible for the contamination of their well water.[486] Prior to this, it is necessary to set out the argument for hydraulic fracking water contamination harm to be subject to a strict liability rule; as such, it is important to ask the following practical and quite pragmatic question: Is it legally justified for fracking to be subject to strict liability rule or has any state adopted such a rule in the exploitation of natural gas from unconventional shale formations? The answer to this question above is certainly in the affirmative. A good example is New York which imposed strict liability for petroleum discharge by statute.[487] However, New York is also deciding to enact a similar law to apply strict liability to HVHF.[488]

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[482]Ibid at p.1 (This trend is also apparent worldwide— "[d]espite rising prices, natural gas is forecast to continue to be the fastest-growing primary fossil fuel energy source worldwide." sims et al.

[483]Howell, K. (2009). More Oversight Sought For Hydraulic Fracturing, *New York Times,* http://www.nytimes.com/gwire/2009/11/04/04greenwire-more-oversight-soughtfor-hydraulic-fracturing-35961.html;' Fracking' For Energy In Northeast: Boon Or Doom?, Environment on MSNBC (Nov. 11, 2010), http://www.msnbc.msn.com/id/40135664/ns/usnews-environment [hereinafter, fracking boon or doom].

[484]Coastal Oil & Gas Corp. V. Garza Energy Trust, 268 S.W.3d 1, 26 (Tex. 2008) (Willett, J., Concurring).

[485]Dye, L. (2008). 'New' Energy Sources Hard On Water Supply, ABC News.Com, http://abcnews.go.com/technology/story?id=4703865&page=1; Paul O'Callaghan, *Energy Versus Water:* (Nov. 10, 2008)). *Is Blue The New Green?* Clean Technica.Com http://www.cleantechnica.com/2008/11/10/energy-versus-water-is-blue-the-new-green/.

[486]Mall, A. (2011). Incidents Where Hydraulic Fracturing is a suspected cause of drinking water contamination, Switchboard: Natural Res. Def. Council Staff Blog, http://www.switchboard.nrdc.org/blogs/amall/incidents_where_hydraulic_frac.html.

[487]See Oil Spill Prevention, Control, and Compensation Act, Newyork Navigation law§ 181 (*Mckinney's consolidated laws of New York).*

[488]Minn, P. (2012). Given the possible presence of petroleum distillates in produced water, one wonders whether § *Thomson Reuters* 181 might eventually form the basis for imposing strict liability in the HVHF Context; See also Assemb. A02108, 2011 Leg., Reg. Sess. (New York 2011).

Here, this work shall begin with a brief discussion regarding the regulatory vacuums using the US as a case study as well as social policy concerns that give justification for the application of a strict liability regime to HVHF.

It is important to note here that because of the deficiencies surrounding the statutes and regulations that govern fracking, many authors, advocates and policymakers have called for a need for change in these statutes and regulations.[489] This gives common law the credentials to play a role in remedying the two fundamental vacuums in statutory regimes that govern the roles in regulating shale gas activities in order to reduce risks.

First, there are two broad categories of damage to be considered that fracking can cause in any shale play. On a larger scale, the cumulative impact of fracking operations on major watersheds around a shale play could affect the availability of clean water for millions of people living and depending on the water resource.[490] On a smaller scale, where discrete accidents have occurred in sparsely populated places, this has resulted in rendering local water supplies unusable.[491]

Large scale damage is more effectively redressed through statutory remedies compared to small scale damage, the reason being that statutory penalties and fines are paid to state or federal agencies, not paid to the victims directly in the USA,[492] whereas common law attributes award damages directly to the victims. For example, if Cabot, an oil and gas company operating in Susquehanna County in the US merely paid the fine to Department of Environmental Protection (DEP),[493] the goal of the affected parties to be made whole and compensated for the damage done to their property is frustrated accordingly.

Second, parties are given leverage to make their own value judgments regarding different courses of action under common law. For example, in situations where companies have discovered that the benefits of fracking outweigh the likely harms, it creates a scenario where operators would prefer to pay continuously for the injuries they caused. In addition, they could also indemnify themselves or decide to settle lawsuits outside of court to avoid tort liability. This invariably circumvents the issues relating to harm arising from breach of contractual agreements up front. These remedies afford the opportunity to companies to extract gas from shale beds and at the same time preserves the property rights and financial security of the property owners. Although large scale damage may not be redressed by using common law features effectively, it certainly ensures that individual property owners are compensated for the loss they suffered as a result**.** Thus, compelling participants to comply with statute requirements.

This singular feature makes legal statutes a potent tool for preventing large scale damage and improving all round environmental quality, but in the case of the individual property owner

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[489]Lustgarten, A. (2004). The hidden danger of gas drilling, B0&. W6, Nov. 24, 2008, at 77, 79, *Available at* http://www.businessweek.com/magazine/content/08_47/b4109000334640.htm (quoting one of the 2004 EPA Study's Original Authors: "It was never intended to be a broad, sweeping study.").

[490]Sawyer, H. (2009). Final impact assessment report. Impact assessment of natural gas production in the New York City water supply watershed 49 (2009), available at http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/12_23_2009_final_assessment_report.pdf (Accessed on 12/06/2017).

[491]Ibid

[492]*E.G.*, Oil & Gas Act, 58 PA CONS. STAT § 601.601 (2011) ("All fines, civil penalties, permit and registration fees collected under this act are hereby appropriated to the department of environmental resources to carry out the purposes of this act.").

[493]Alonso, P. W. (2010). Dimock, a town fractured, water contamination from shale, [Online] htpp;//www.water-contaminantion-from-shale.com/story_3.php (Accessed 20/06/2017).

in an area with widespread drilling, where it is difficult to prevent harm, and the main focus is on compensating for damage already done,[494] common law is the better tool.

As a justification for the application of a strict liability rule, it is also important to note some advantages it has over a negligence standard. While strict liability does not involve the additional steps of ascertaining whether the defendant was negligent or breached a duty, negligence standards rely heavily on this resolve. As a result, a strict liability standard relies less on the facts of a case, and in order to achieve recovery, it does not require proof of the defendant's negligent behaviour,[495] on the basis that fewer facts need to be alleged. Therefore, the administrative cost of suits is reduced, and affected parties are further encouraged to seek relief in the first place if strict liability is applied. There is also an improvement in the uniformity and accuracy of judicial decisions.

Strict liability is also advantageous over negligence because it tends to discourage excessive risk taking on the part of the oil and gas companies. This is simply because drilling companies are well equipped to know the risks involved in fracking and how to mitigate the dangers than landowners. As a result, it is preferable that the general public holds these oil and gas companies strictly liable instead of landowners to prove whether the company was negligent.

6.2 The Statutory and Regulatory Concerns of Allowing HVHF

6.2.1 Oil and Gas and Fracking Fluids Related Wastes are exempted from Regulation under RCRA.

The RCRA was enacted by Congress in 1972 for managing hazardous waste.[496] A temporary provision was made by Congress in 1980 exempting "drilling fluids, produced water, and other wastes linked to exploration, development, or production of crude oil or natural gas or geothermal energy" from the Act's regulation.[497]

Whilst it was the intention of Congress that the exemption should last for at least two years[498] during which the EPA was to conduct a study, Congress would "determine either to enact regulations for oil and gas related wastes… or that such regulations were unwarranted".[499] For some reason, after the completion of the study by the EPA in 1987[500] and 1988, the EPA reached a conclusion by issuing a determination that regulation was unwarranted.[501]

Hence, this exemption has been one of the components of the regulatory vacuum that is associated with the management of wastes linked to oil and gas field exploration and

[494]Baca, M. C. (2010). Pittsburgh bans natural gas drilling, P-!P0?1*4, http://www.propublica.org/article/pittsburgh-bans-natural-gas-drilling; Eric Boehm, (October,2010). P*ennsylvania still only state without natural gas severance tax*, Statehouse news online (2010), http://statehousenewsonline.com/2010/10/21/pennsylvania-stillonly-state-without-natural-gas-severance-tax.

[495]*See* Gerrity Oil & Gas Corp. V. Magness, 946 P.2d 913, 919–20 (Colo. 1997); Pioneer Natural Res. USA, Inc. V. W.L. Ranch, Inc., 127 S.W.3d 900, 907 (Tex. App. 2004) (Citing Broders V. Heise, 924 S.W.2d 148, 149, 152-53 (Tex. 1996).

[496]*See* Resource Conservation and Recovery Act (RCRA) Of 1976 § 2, 42 U.S.C.§D6901 (2006).

[497]Sold Waste Disposal Act Amendments of 1980 §D7, 42 U.S.C. § 6921(B) (2) (A) (2006).

[498]Ibid (stating that "Oil- and gas-related wastes are] subject only to existing state or federal regulatory programs in lieu of this subchapter until at least 24 months after [The date of enactment.").

[499]42 U.S.C. § 6921(B) (2) (B). Any such regulations would "Take effect only when authorized by Act of Congress." § 6921(B) (2) (C).

[500]Regulatory determination for oil and gas and geothermal exploration, development and production wastes, 53 Fed. Feg. 25,446, 25,448 (July 6, 1988) (also stating that EPA did not begin the study until after the Alaska centre for the environment sued EPA in 1985).

[501]Ibid at p. 25, 447, 25 and 456.

production operations,[502] for which shale gas fracking shares similarity. This has also been a subject of criticism. The EPA underlying study of 1987 that resulted in the Agency's determination of 1988 have been criticised as being politically motivated[503] and some petitions were filed against the Agency to reconsider its position.[504] Still, the determination that the regulation of oil and gas related wastes under the RCRA remains unwarranted is the law of the land today.[505]

6.2.2 Safe Drinking Water Act (SDWA) Exempts Fracking from Regulation, Except When Diesel is used as a Fracking Fluid Additive.

The EPA reached an agreement with three major fracking companies in which the companies agreed to voluntarily eliminate the use of diesel fuel in fracking fluids,[506] while the EPA conducted a study of fracking in CBM fields in 2003.[507] The study's recommendation in 2004 discussed the potential danger of the use of diesel fuel in fracking.[508] However, the study down played the dangers posed by CBM fracking overall.[509] The voluntary diesel elimination agreement between the Agency and relevant companies in 2003 was used as a justification for downplaying the threats CBM fracking posed and stated that companies "no longer use diesel fuel as a hydraulic fracking fluid additive".[510]

The Act expressly prohibited an underground injection not approved by a permit issued by the EPA[511] as well as prohibiting the promulgation of any rule authorising any underground injection which posed a threat to drinking water sources.[512] Despite the ruling of the Eleventh Circuit Court of Appeals in 1997 and 2001 which viewed fracking as an "underground injection" activity that ought to be regulated under SDWA,[513] In 2005 Congress specifically

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[502]Cox, J. R. (2003). Revisiting RCRA's oilfield waste exemption as to certain hazardous oilfield exploration and production wastes, *Villona Environmental Law Journal* Volume 14, 1.

[503]Urbina, I. (2011). Pressure Stifles Efforts To Police Drilling For Gas*, N.Y. Times, March 4, et a1, Available at* http://www.nytimes.com/2011/03/04us/04 gas html?ref=waterpollution ("E.P.A. Official told the author of the 1987 study that her findings were altered because of pressure from the office of legal counsel of the White House under Ronald Reagan")

[504]Letter from Amy Mall, Senior Policy Analyst, Natural Res. Def. Council and Diane Donnelly, Legal Intern, Natural Res. Def. Council, to Lisa Jackson, Adm'r, EPA 2, 6–7 (Sept. 8, 2010), *Available At* http://docs.nrdc.org/energy/5les/ene_10091301a.pdf. (Accessed on 20/06/2017)

[505]See Crude Oil and Natural Gas Waste, EPA, http://www.epa.gov/osw/nonhaz/industrial/special/oil/ (last updated July 27, 2011).

[506]Memorandum of Agreement between EPA and BJ Servs. Co., Halliburton Energy Servs., Inc., And Schlumberger Tech. Corp.: Elimination of diesel fuel in hydraulic fracturing fluids injected into underground sources of drinking water during hydraulic fracturing of coalbed methane wells 2, 5 (Dec. 12, 2003) [Hereinafter moa, elimination of diesel fuel], *available at* http:// www.epa.gov/ogwdw000/uic/pdfs/moa_uic_hyd-fract.pdf. (Accessed 4/02/2017).

[507]Office of the Ground Water & Drinking Water, EP, EPA 816-f-04-017, evaluation of impacts to underground sources of drinking water by hydraulic fracturing of coalbed methane reservoirs; national study final report 1 (June 2004), available at http://www.epa.gov/ogwdw/uic/pdfd/cbmstudy_attach_uic_final_fact_sheet.pdf. (Accessed 21/06/2017).

[508]Ibid §D7.2, at 3-7.

[509]Ibid.

[510]Ibid §7.2 at 7-3 (EPA also indicated that the three companies that signed the2003 diesel agreement accounted for "approximately 95 percent of the hydraulic fracturing projects in the United States.")

[511]Safe Drinking Water Act (SDWA), 42 U.S.C. § 300h (B) (1) (A) (2006).

[512]Ibid §D300h (B)(1)(B).

[513]Legal Environmental Assistance Found. V. EPA (*LEAF I*), 118 F.3d 1467, 1478 (11th Cir. 1997) (holding that fracking must be regulated by the state of Alabama under the provisions of SDWA), superseded by statute, Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594; Legal Envtl. Assistance Found. V. EPA (*LEAF II*), 276 F.3d 1253, 1265 (11th Cir. 2001) (Upholding the Alabama Regulations Promulgated After The 5rst LEAF

exempted fracking from regulation under SDWA in 2005.[514] Moreover, the exemption does not cover the use of diesel fuel for fracking as it is still considered an underground injection.[515]

6.2.3 Under other Federal Statutes, Oil and Gas Related Activities and Substances are exempted from Regulation.

Aside from the RCRA and SDWA, discussed above, which constitute the main examples of fracking exemptions from the entire gamut of federal regulation, there are other federal statutes containing their exemptions and exclusions for different elements of the natural gas exploration process. These statutes comprise CERCLA,[516] the Clean Water Act,[517] as well as the National Environmental Policy Act (NEPA).[518]

As will be seen in the subsequent sections, these regulatory lee-way show that some oil and gas related activities and wastes have been exempted from federal regulation, thereby leaving the tasks to state and local governments to deal with.[519]

6.3 The Social Policy Concerns of Allowing HVHF

The final three factors under the Restatement (Second) of Torts are clearly fact sensitive and touch on the social policy issues[520] that define whether strict liability should be applicable to the harms caused by fracking operations. Factor (e) the extent to which the activity is not a matter of common usage, from the discretions of the court's interpretation, limited the doctrine of strict liability. This factor from case law assumes that a common activity will be "a well-developed technology with reciprocal risk exchange between participants and bystanders".[521]

Decision), *Cert. Denied*, 537 U.S. 989 (2002), Superseded by Statute, Energy Policy Act Of 2005, Pub. L. No. 109-58, 119 Stat. 594.

[514]Energy Policy Act of 2005, Pub. L. No. 109-58, §D322, 119 Stat. 594, 694 (Codified at 42 U.S.C. §D300h (D) (2006)). while the bill was being debated in 2005, amendments proposed by representatives Diana Degette and Hilda Solis, which would have preserved some federal oversight of fracking, failed in committee. h.r. rep. no. 109-215, pt.1, at 491 (2005) .II The Senate, Senator Jim Jeffords introduced a separate bill that would have subjected fracking to SDWA's provisions. s. 1080, 109th Cong. (2005).

[515]42 U.S.C. §D 300h(D) ("The term 'underground injection'…excludes…the underground injection of fluids or propping agents (*other than diesel fuels*) pursuant to hydraulic fracturing operations..." (Emphasis added).

[516]Although CERCLA contains reporting requirements for some fracking chemicals, 40 c.f.r. §d302.4 (2008); office of emergency management EPA for discussion of the legislative history of this exclusion, See Roger Armstrong, CERCLA's Petroleum Exclusion*: Bad policy in a problematic statute*, 27 LOY L.A. L. REV. 1157, 1159–77 (1994).

[517]"[M]ining operations or oil and gas exploration, production, processing [and] treatment operations [and] transmission facilities" are exempt from the clean water Act's permitting requirements for storm water runoff 33 U.S.C. §D1342(*L*)(2) (2006). EPA has determined that this exemption extends to oil- and gas-related construction. Amendments to the National Pollutant Discharge Elimination System (NPDES) Regulations for Storm Water Discharges, 71 Fed. Reg. 33,628, 33,630 (June 12, 2006.

[518]NEPA requires Federal Agencies to Prepare Detailed Environmental Impact Statements and "include [them] in every recommendation or report on proposals for legislation and other major federal actions significantly affecting the quality of the human environment..." 42 USC. §d4332(c) (2006). In 2005, NEPA was amended to include a "rebuttable presumption that the use of a categorical exclusion…would apply if [certain activity] is conducted...for the purpose of exploration or development of oil or gas." Energy Policy Act of 2005 §D390, 42 U.S.C. § 15, 942 (2006).

[519]Trotta, D & Honan, E. (2011). Hydraulic Fracking Banned in Buffalo*, New York, Huffington* Post', http://www.huffingtonpost.com/2011/02/09/hydraulic-fracturing-bann_n_820647.html; Baca, M. C. (2010). Pittsburgh Bans Natural Gas Drilling, *Propublica,* http://www.propublica.org/article/pittsburgh-bans-natural-gas-drilling.

[520]Hoffman, N. R. (2010). 'The feasibility of applying strict-liability principles to carbon capture and storage' *Washburn Law Journal*. Volume 49, pp.527, 537–38.

[521]Ibid at 542.

The first duty of the court is to determine whether hydraulic fracking is a matter of common usage at the location. Comments from the Restatement infers that oil drilling could be abnormally dangerous if it is done in other areas instead of designated oil lands.[522] There is no clarity yet as to how common an activity must be in order to succeed the common usage test. In the same vein, there is no clear delineation as to what locations are appropriate for hydraulic fracking.[523] Oil and gas companies have been held strictly liable by previous courts for wells in densely settled communities[524] but not in rural areas.[525] The definition of 'rural' is particularly open to a broad interpretation. For purpose of illustrating this, towns where contaminations occur that are located approximately thirty minutes away from a major populated city is deemed sufficiently rural.[526] What is expected of the court is to evaluate the nearness of the hydraulic well to the plaintiffs' property and water supply in any fracking cause of action.[527]

The case of *Branch v W. Petrol., Inc,*[528] showed something very interesting in the sense that the well was drilled less than 2,000 feet (0.38 miles) and others as low as 400 feet from the residence of the plaintiffs and water supplies.[529] From the above case, it is fair to say that the well drilled at that distance makes fracking to be inappropriately located. This is because distance plays a role in arriving at what is appropriate when it comes to determining an activity's abnormally dangerous character vis-à-vis factor (c). Therefore, strict liability should apply to fracking as one of the policy options proposed in this thesis. This is without prejudice to a defendant's claim to have exercised reasonable care because risk cannot be eliminated at a depth where a well was drilled only 400 feet from a person's water supply.[530]

In addition, fracking qualifies as a non-natural use of land based on the history of where fracking currently takes place. Fracking transports minerals from the bedrock to water located above the bed rock, which ordinarily would not have happened.[531] A similar decision was reached by the court in *Pneumatic Gas Co.* v. *Berry*[532] where the defendant was held strictly liable for oil drilling operations carried out close to the plaintiff's residence that brought salt water to the surface which later led to the contamination of the plaintiff's drinking water.[533]

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[522]See Restatement Cmt, I (Second) of Torts § 520 (1977).
[523]See Restatement (Second) of Torts § 520 Cmt. J (1977).
[524]*See* Green V. Gen. Petrol. Corp., 270 P. 952, 956 (Cal. 1928) (awarding plaintiffs damages for oil contamination of their residential property); Tyner V. People's Gas Co., 31 N.E. 61, 62 (Ind. 1892) (affirming an injunction against a natural gas well 200 feet from plaintiff's domicile).
[525]See Restatement (Second) of Torts § 520 Cmt. K (1977).
[526]The town of Kingsley, PA http://kingsleystation.community.officelive.com/default.aspx (Accessed 19/01/2016); Driving Directions From Kingsley, PA To South Gibson, PA, google maps, http://www.maps.google.com (follow "get directions" hyperlink; then search "a" for "Kingsley, pa" and search "b" for south gibson, pa"; then follow "get directions" hyperlink).
[527]Branch V. W. Petrol., Inc., 657 P.2d 267, 270 (Utah 1982) (Taking into account the proximity of the plaintiff's well to the activity in holding the defendant strictly liable); Restatement (Second) of Torts § 520 cmt. K (1977)
[528]Ibid.
[529]*See* Complaint for petitioner, Berish *et al,.* V. Sw. Energy Prod. Co., No. 210-1882CP, 2010 WL 4230599 (M.D. Pa. Sept. 14, 2010), *available at* http://graphics8.nytimes.com/ images/blogs/greeninc/complaint.pdf [hereinafter berish complaint]; amended complaint, Fiorentino V. Cabot Oil & Gas Corp., No. 3:09-Cv-02284-TIV, 2010 WL 931974 (M.D. Pa. Mar. 5, 2010) [hereinafter Fiorentino Complaint].
[530]*See Branch*, 657 P.2d at 270 (Imposing strict liability because dumping formation water adjacent to plaintiff's property was too close).
[531]See also, 'Fracking' (2010). Mobilizes Uranium in Marcellus Shale, Eurekalert! http://www.eurekalert.org/pub_releases/2010–10/uab-mu102510.php. (Accessed 24/06/2017).
[532]Pneumatic Gas Co. v. Berry 11. U.S 322 (1885).
[533]Ibid.

The rationale behind the court's decision was that "the salt water had been harmless as long as it was left in the ground, but once it was raised to the surface of the earth it became a harmful solvent".[534] The court added that [t] he right to recover results from the company having the harmful substance on its land and permitting it to escape to the damage of plaintiff."[535] The unnatural minerals brought to the water level by fracking shared lots of similarity with the salt water in the *Berry's case*[536] which produced harm that gives credence to need to apply strict liability under factor (e).

Finally, factor (f) deals with the importance attached to the activity. Here, what is applicable is that it provides the opportunity to weigh the importance of domestic energy and local economic growth against the importance of clean water.[537] What this means is that if fracking operations are sufficiently valuable to a community or a nation, the court may not see it as abnormally dangerous because of the value of the activity itself.[538]

Regardless, what is valuable is also open to wide interpretation. It is a relative term if certain idiosyncrasies of individuals are taken into consideration. What is valuable sometimes is based on the choice of the individual and any attempt to impose it would be a negation of what is fair and just to that individual. In the opinion of this thesis, what is valuable should be dictated by an involuntary phenomenon, something that one does not have the requisite will to resist or where there is no close substitute to that seemingly valuable commodity.

For instance, the air we breathe is a very valuable commodity like the water we drink. One does not choose to breathe, you breathe in oxygen involuntarily to survive. It is not out of choice. Take for example the need to understand what the value of an activity like fracking is. For instance, by virtue of the location of the fracking activities, the land owners around where a prospective hydrocarbon source was discovered will be entitled to the payment of royalties.

To some, they may simply refuse granting those rights to the oil and gas companies either by choice or by the perception they have formed regarding the negative implication that such activities create. Whereas, there are some individuals who might be willing to bequeath such right to these companies but because they do not have actual title to land they cannot enjoy such royalties that might accrue from such. It follows from these conflicting scenarios that what is valuable depends on the choice of the individual involved, their willingness and the availability of the land to be entitled to such benefits coming with fracking activities.

The contamination that fracking causes to drinking water is enormous compared to the benefits it gives to the community. Water is a commodity that no one can do without, whereas the said job opportunities and the royalties that accrue to citizens of that community and land owners, respectively, are dictated by certain factors. These factors include: job vacancies and the qualification of the individual desirous of working for the oil and gas companies.

Due to the limited job vacancies available in an oil and gas drilling company, not everyone qualified might work in that community at the time when such developmental activity is taking place. The aged and those physically challenged or those suffering from health conditions might not benefit from the job opportunities that resource extraction claims to present. However, it is a known fact that water as a commodity is sought and beneficial to all classes of people at all time, irrespective of age and the disability of the individual. Hence,

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[534]Ibid.
[535]Ibid.
[536]See supra *Branch*, 657 P.2d at 270 foot note 530.
[537]Coastal Oil & Gas Corp. V. Garza Energy Trust, 268 S.W.3d 1, 26–27 (Tex. 2008) (Willett, J., Concurring).
[538]Krauss, C & Zeller, T. (2010). When a rig moves in next door, *New York Times,* Nov. 7, 2010, at BU7.

the contamination of ground water affects all the residents within that community that depend on it as a source of drinking water.

Water is a unique commodity that should not be compromised at any level. Before the advent of human civilisation, humans have survived without electricity, without jobs from oil companies, but one is yet to find an individual who has survived through time without access to quality water. There must be the outbreak of water related disease in the long run where water is contaminated.

Therefore, based on these arguments it is clear that an activity like fracking that has the ability to contaminate ground water and water resources suggests that the activity is abnormally dangerous, and that the risks outweigh the benefits. This is because a great mass of mankind absolutely need water and there is neither a substitute to groundwater nor is there a remedy to such dangerous contamination. The number of people who involuntarily need this water for sustenance is not based on choice, but those who might derive benefits from fracking is based on choice and some other factors already identified above.

Thus, an application of strict liability as a policy palliative in mitigating shale gas associated risk is necessary to make the plaintiff whole, as well as to show the truce that the dividends of achieving water quality outweighs the benefits of fracking which are temporary. As a result, the threat of contamination from hydraulic fracturing is not an issue that is the exclusive preserve of the plaintiff(s) in a case; but any other party interested in the future water quality within that community where fracking is taking place.

Interestingly, the application of strict liability would not result in the termination of hydraulic fracturing in countries where it is ongoing nor in countries intending to commence because the industry knows that what it will gain will always outweigh the cost of a strict liability regime. Rather it would address the challenges encountered by drilling companies regarding acquisition of private land. Land owners would be more willing to lease their lands for such purposes knowing that the defendant is strictly liable for any damage therein.[539]

In the same vein, it creates a significant incentive on the part of the defendants, and makes them more likely to explore not only the best alternative drilling technologies, but also explore alternative drilling areas based on best practice.[540] As the doctrine imposes cost for accidents, a compromise is reached between those who want to drill and explore oil and natural gas through fracking and those agitating for a ban on fracking.[541]

6.4 Difficulties Inherent in Some Theories of Law Determining where Defendant's Liability Lie Vis-À-Vis Fracking

As the future regulation of fracking still remains uncertain in some regions blessed with these resources, certain theories of law offer steps in the right direction for victims who may have been impacted negatively to recover for environmental damage or loss to chattel caused by HVHF.[542] Among these theories are include private nuisance, trespass and negligence which may be applicable to cases related to fracking. However, in order to successfully promote the application of strict liability involving fracking operations kind of harm, particularly water

[539]Jones, W. K. (1992). 'Strict liability for hazardous enterprise' 92 Colum. L. Rev. 1705, 1709 (detailing how *Ryland's* established the strict liability doctrine).
[540]*See* Industry Harbor Belt R.R. Co. V. Am. Cyanamid Co., 916 F.2d 1174, 1177–78 (7th Cir. 1990).
[541]See supra Tiemann. M & Vann, A. (2013) footnote 395.
[542]Second amended complaint, Fiorentino V. Cabot Oil & Gas Corp., ¶¶D64–87 (stating claims for negligence, nuisance, and strict liability).

contamination, it is pertinent to examine the difficulties and challenges inherent in the other theories of proof of private nuisance and trespass.

6.4.1 The Unclear Nature of the Law of Subsurface Trespass with Respect to Fracking and Other Underground Injections

Applying the law of trespass to oil and gas related activities is quite difficult.[543] This is because most oil and gas operations like fracking take place beneath the surface, and this leads to the next question one would want to ask, whether the rule of trespass applies at all. The notion of law that states that ownership is the same on, above, and below the surface when it comes to rules relating to surface and subsurface trespass has lost its potency in current civil legal systems.[544] Although the same rule of law is being applied for over sixty-five years in jurisdictions where common law doctrines still have a contribution in dealing with certain liability issues, it is no longer tenable.[545]

The court in the case of *Fiorentino V. Cabot Oil & Gas Corporation's*[546] rejection of the doctrine where ownership is the "same on, above and below surface"[547] by the regime has resulted in a situation where courts are not inclined to apply the law of trespass to oil and gas suits except where some degree of harm has occurred on the surface.

A case at hand is *Coastal Oil & Gas Corp. v. Garza Energy Trust,* the Texas Supreme Court in an *obita dicta* said that if chemicals were found to have been spilled on the surface, trespass would then be applicable, but held that fracking is a subsurface activity and did not constitute trespass in that instance.[548] Consequently, the Kansas Supreme Court held in *Crawford v, Hrabe* that injecting salt water into the ground to enhance production is a right that the well operator has, even where consent is not given by the lessor, and that this act of injection was not seen as trespass.[549]Just like Justice Willett's concurrence in *Garza,* in holding for the defendants, the court referred to drilling as economically beneficial in nature.[550]

However, in some limited situations, the law of trespass may still be applicable. For example, in *Starrh & Starrh Cotton Growers v. Aera Energy,* a court in California held that an act of migration of water from an oil drilling activity onto cotton-growers' land was a continuous subsurface trespass.[551] Also, the Tenth Circuit held that a lower court had sufficient proof when it concluded that the migration of gas from one subsurface formation to another was a breach of trespass law.[552] Therefore, it becomes difficult to find a clear cut position in these cases. While in the cases of *Crawford and Garza,*[553] courts have adopted a broad interpretation of the rights of mineral lessees and as such, have permitted them to continue activities like drainage and underground injection because of their economic benefits, whereas, in cases like

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[543]Keeton, W. P *et al.,* (1984). Prosser and Keeton on the law of torts 72 (5th Ed., Lawyer's Ed. 1984) (discussing difficulty of applying the law of trespass where "deleterious liquids such as crude oil, salt water, gasoline, and the like" are concerned).

[544]An example of where this rule of trespass has been applicable is in the u.s particularly in the case of *United States V. Causby, 328 U.S. 256, 260–61 & N.5 (1946).*

[545]Ibid (quoting the fact that the rule of trespass is been functional for over sixty years in the U.S).

[546]See supra Industry Harbor Belt R.R. Co. V. Am. Cyanamid Co foot note 540.

[547]Ibid.

[548]Coastal Oil & Gas Corp. V. Garza Energy Trust, 268 S.W.3d 1, 11 (Tex. 2008).

[549]Crawford V. Hrabe, 44 P.3d 442, 452–53 (Kan. 2002) (holding that a lessee of mineral rights has all privileges necessary for producing minerals pro5tably, and 5nding that subsurface injection was necessary in this instance).

[550]See supra Coastal Oil & Gas Corp. V. Garza Energy Trust footnote 537 at p.268 (Willett, J., concurring).

[551]Starrh & Starrh Cotton Growers V. Aera Energy LLC, 63 Cal. Rptr. 3d 165, 174 (Ct. App. 2007).

[552]Beck V. N. Natural Gas Co., 170 F.3d 1018, 1022 (10th Cir. 1999).

[553]See supra Crawford V. Hrabe foot note 549.

Starrh and Beck,[554] companies were held liable for the consequences of water and gas migration. Thus, the difficulty of determining where fracking cases that contain features of both fit on this spectrum.

6.4.2 For Private Nuisance, Proof of Intent May be Difficult to Establish in a Fracking Case

The doctrine of private nuisance allows for recovery for unreasonable conduct. Nuisance is the interference with "another's interest in private use and enjoyment of land" either intentionally and unreasonably, or unintentionally and otherwise actionable under the rules of negligence.[555] Because intent is a key requirement to be fulfilled in private nuisance cases, it is therefore imperative that it is established fully. However, it is easier to establish intent in many ways, but to prove specific intent is often a hard nut to crack. In *Hughes v. Emerald Mines Corp.,* where a mining operation resulted in the contamination of water wells belonging to a nearby landowner, the court allowed them to recover by applying private nuisance.[556] Although the specific intent requirement was not fulfilled, the mining company was held liable because of the knowledge of substantial certainty that the mining company had regarding an imminent contamination in the event of an accident was enough to satisfy the requirement of intent.[557]

To prove private nuisance, intent can also be established when a defendant intentionally carries out an activity that was not originally meant to interfere with another's interest.[558] Hence, the three varieties of intent: specific intent; substantial certainty; and intentional continuation of an initially unintentional act is key in establishing intent in private nuisance cases. All of these are not easy to prove by the plaintiff in any cause of action for recovery.

Also, to prove intent alone is not sufficient to establish private nuisance; the alleged interference must be unreasonable in action.[559] The ease with which the plaintiffs proved intent in the *Hughes Case* cannot be the same way intent would be proven in fracking cases. Likewise, plaintiffs in fracking cases will be unable to establish the 'specific intent' requirement for the application of nuisance. More so, plaintiffs in fracking cases will find it tough to also prove that the defendants drilling companies were substantially certain that their operations would result in harm. Drillers will conclude that fracking is safe based on the studies in order to defend themselves against accusations of substantial certainty if wells are drilled properly and no accidents occur.[560]

In the face of a lack of a further scientific evidence that might help the plaintiffs, proving substantial certainty will be difficult. Nevertheless, to establish that drilling companies intentionally continued a harmful act is achievable if plaintiffs can also show that the drillers continued that harmful act despite a prior knowledge that it was causing a contamination

[554]See supra Marcovici, M. (2013) footnote 353.
[555]Restatement (Second) of Torts'& §D822 (1979).
[556]Hughes V. Emerald Mines Corp., 450 A.2d 1, 8–9 (Pa. Super. Ct. 1982).
[557]Ibid at p.6-7.
[558]Anderson. O. (2009) Subsurface trespass after *coastal v. Garza* 30, *available at* http://groundwork.iogcc.org/sites/default/5les/owen%20anderson%20paper,%20subsurface%20trespass%20after%20coastal%20v%20garza.pdf (Accessed on 29/06/2017).
[559]*See* Restatement (Second) of Torts § D822(A) (1979).
[560]Bureau of Oil & Gas Regulation, New York State Department of Environmental Conservation (explaining factors that can enable adefendant claim defence.)

anyway.[561] Accordingly, the inclusion of knowledge as an element further exacerbates the matter.[562]

In the same light, in ascertaining whether the mining company ought to be held liable for the contamination, according to the *Hughes Case,* the value of the act must be weighed against the negative effects resulting from that act in determining its reasonableness.[563] In sum, in order to establish the reasonableness component is quite easy to apply to a fracking case than intent; but the potential for water contamination in *Hughes* is similar to the potential that exists in place for fracking, and the economic utility of coal mining in *Hughes* parallels the utility of fracking.

6.4.3 The Difficulties of Defining Due Care and Determining Whether Exercising such Care will Prevent Harm makes the Application of Negligence Problematic.

Regarding negligence claims, the requirement for the proof of intent is not necessary.[564] However, the plaintiff is required to show not only that the defendant did cause the harm, but the plaintiff further has to prove that the defendant acted negligently by doing so.[565] This is an additional obstacle for the plaintiff. In this regard, for determining whether the plaintiff has overcome this obstacle, the courts balance the severity and probability of injury against the burden of prevention. In the case of *Ind. Harbor Belt R.R. Co. v. Am. Cyanamid Co.,*[566] Judge Richard Posner articulated that for negligence to be a workable regime, an activity's hazard can be avoided by exercising care. What it then means is that there is no need to resort to strict liability where the exercise of care can prevent an activity's harm.[567]

An application of negligence to fracking related health and environmental challenges requires a Judge to first conclude that the dangers of fracking can be avoided while exercising due care by the defendant. The courts are faced with two tasks. First, due care must be defined in relation to drilling, fracking and with respect to other activities like surface-water withdrawal, flow back water disposal, and well construction. Second, the court must ascertain whether when drilling companies adhere to the standard of due care, and the threat of environmental damage can be avoided. Moreover, to determine the standard of care in negligence cases, courts typically rely on expert testimony.[568]

It was held by a Texas court in 2004 that problems with drilling equipment in drilling oil wells is to be expected but cannot be the ground for a negligence cause of action.[569] Thus, it is worth noting that there is no assurance from the oil well drillers that there will not be problems with

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[561]See Burr V. Adam Eidemiller, Inc., 126 A.2d 403 (Pa. 1956).
[562]Gobrecht V. Beckwith, 135 A. 20, 22 (N.H. 1926) (Illustrating that a requirement of knowledge may impose a duty to "investigate and 5nd out," depending on the nature of the activity and the defendant's relationship to others) scienti5c uncertainty therefore makes intentional continuation of a harmful act difficult to prove, just as it makes substantial certainty difficult to prove.
[563]See supra footnote 441 (Pa. Super. Ct. 1982) (Concluding that defendant mining company's conduct was unreasonable and holding the company liable).
[564]Compare Restatement (Second) of Tort § 166 (intent is a required element of trespass, unless the trespasser is engaged in an "abnormally dangerous" activity), § 281 (no requirement of intent to prove negligence).
[565]United States V. CDMG Realty Co., 96 F.3d 706, 722 (3d Cir. 1996) ("[Plaintiff] has identi5ed evidence that would justify a fact5nder's conclusion that contaminants were dispersed... Nevertheless, [plaintiff] must show not only that the soil investigation caused the spread of contaminants but also that the investigation was conducted negligently.").
[566]916 F.2d 1174, 1177 (7th Cir. 1990).
[567]Ibid.
[568]See Gerrity Oil & Gas supra footnote 488; Pioneer Natural Res. USA, Inc. V. W.L. Ranch, Inc., 127 S.W.3d 900, 907 (Tex. App. 2004) (Citing Broders V. Heise, 924 S.W.2d 148, 149, 152-53 (Tex. 1996)).
[569]Ibid.

the drilling equipment.[570] This sends a message that some accidents and complications are anticipated. Following the combined authorities of Judge Posner and the Texas courts, serious doubts exist whether being careful can avoid the hazards of an activity.[571] Therefore, arguments for a negligence standard becomes more tenuous due to the complex geology involved in unconventional shale drilling.[572]

6.5 Arguments to Show the Abnormality in Fracking Harms and the Application of Strict Liability vis-à-vis Water Contamination

The plaintiff need not prove a breach of a duty of care by the defendant in order to apply the strict liability doctrine. What is expected of the plaintiff is to prove whether the defendant's actions reasonably caused the damage.[573] In certain legal regimes, it is the rule of negligence that is applicable.[574]

On the other hand, strict liability is confined to an 'abnormally dangerous activity'. *The Restatement (Second) of Torts* captures the criteria for determining an abnormally dangerous activity doctrine: First, one who undertakes an abnormally dangerous activity is made liable for harm caused to the person, land or chattels of another as a result of the activity, even where there has been an exercise of utmost care to prevent the harm.

Second, strict liability is limited to the nature of harm, and the definition of what makes the activity abnormally dangerous.[575] Now what makes strict liability viable for fracking activities is borne out of the doubt about whether it is possible to avoid the dangers of fracking simply by exercising due care.[576] Two fundamental questions require answers prior to the substantive argument for the application of a strict liability doctrine to fracking water contamination harm: (1) whether strict liability is a viable cause of action in fracking claims? (2) Whether fracking is abnormally dangerous to warrant a strict liability rule?

For the first question, it is indeed a viable cause of action. However, for the second question, it is not an abnormal activity, but the kind of harm (water contamination) qualifies it to be an abnormally dangerous activity. Therefore, strict liability can be applied to address this obstacle. At this juncture, it is necessary to give some logical reasons for the answers proffered.

6.5.1 The Viability of Strict Liability in Fracking Claims.

The plaintiffs in the case of *Fiorentino v. Cabot Oil & Gas*, as part of the causes of action, included strict liability on the premise that the dangerous nature of the chemicals used in fracking fluid is abnormally dangerous.[577] The defendant argued that as a matter of law, "the Superior court of Pennsylvania has viewed that petroleum related storage and transmission

[570]*Pioneer*, 127 S.W.3d at 907.
[571]Industrial Harbor Belt R.R., 916 F.2d at 1177.
[572]*Cf.* Kuuskraa & Stevens Advanced Research International Incorporation.
[573]Restatement (Second) of torts § 519 (1979).
[574]For example, the United States, Nigeria, and United Kingdom.
[575]See supra State Department of Environmental Protection v. Ventron Corp footnote 459.
[576]Ibid at § 520.
[577]Second Amended Complaint ¶D 47, Fiorentino V. Cabot Oil & Gas Corp., No. 3:09-Cv-02284-TIV (M.D. Pa. May 17, 2010), 2010 WL 2070478. ¶¶D84–87 (The hazardous chemicals and combustible gases used, processed, and stored by defendants are of a toxic and hazardous nature capable of causing severe personal injuries and damages to persons and property encountering them, and therefore are ultra-hazardous and abnormally dangerous.").

activities are neither abnormally dangerous nor ultra-hazardous"[578] with a view to discredit the cause of action filed by the plaintiffs as no specific claim was mentioned for relief to be granted.[579]

The plaintiffs however, gave a counter argument that no precedent "pertaining to the *drilling and operations of gas wells* through fracking exist so far" and that the instant activities are nothing like those considered in the Pennsylvania cases Defendant cited".[580] The contention of the plaintiffs was accepted by the Judge and allowed the cause of action for strict liability. From the above case, it is evident that the notion that strict liability is a viable cause of action in fracking cases is obviously predicated upon the facts and precedents regarding the drilling and operation of gas wells.

In this regard, there are no precedents regarding the level of risk and the degree of harm from the process. Therefore, as long as there are no established precedents regarding the operations of gas drilling through fracking, then strict liability becomes a viable cause of action which would be determined based on facts discovered for ascertaining where liability lies.

In the case of *Berish v. Southwestern Energy Production Co.,* it was the conclusion of the court that "since the determination of whether or not an activity is abnormally dangerous is in fact a sensitive argument, courts often wait until discovery is complete before making this determination".[581] In the interim, courts are refusing to see strict liability as a viable cause of action during pre-trial motions. Instead, courts prefer to wait until after all necessary facts are discovered. Nevertheless, their willingness to wait until after discovery of the facts suggests that the determination of strict liability to fracking will be based on relevant facts, not necessarily that it is an inappropriate option for all classes of cases in future.

6.5.2 Fracking is not an Abnormally Dangerous Activity, but the Kind of Harm makes it Abnormally Dangerous.

The hallmark of strict liability is dependent on the kind of harm an activity can cause. This makes the activity technically abnormally dangerous.[582] The question is whether fracking harm qualifies as abnormal in the context of strict liability doctrine. The answer is in the affirmative when one look at the wide variety of environmental damages, particularly water contamination. For a discussion as to why water contamination harm makes fracking an abnormally dangerous process, see discussion relating to the social concerns of allowing hydraulic fracturing (section 6.3*).* Such possibility of damage is what makes fracking contentious and dangerous.[583]

Thus, regarding the way forward on the controversies surrounding fracking operations, it is the recommendation of this thesis that fracking in its entirety in terms of the risks it creates, should not be subject to a strict liability doctrine on one hand. On the other hand, since strict liability is limited to the kind of harm, the abnormality it creates should be evaluated first

[578]Ibid at 16–17. Cabot relied on *Melso V. Sun Pipe Line Co.*, 576 A.2d 999, 1003(Pa. Super. Ct. 1990) (Refusing to apply strict liability for pipeline under residential development), and Smith v. Weaver, 665 a.2d 1215, 1220 (Pa. super. ct. 1995) (holding that strict liability does not apply to the operation of underground storage tanks).
[579]Memorandum of law in support of defendants' motion to dismiss plaintiff's second amended complaint at 1, Fiorentino V. Cabot Oil & Gas Corp., No. 3:09-Cv-02284-TIV, 2010 WL 2286902.
[580]Plaintiffs' memorandum of law in opposition to defendants' motion to dismiss at 9, *Fiorentino*, No. 3:09-Cv-02284-TIV, 2010 WL 2666301.
[581]Berish V. SW. Energy Production Corporation., 763 F. Supp. 2d 702, 705 (M.D. Pa., 2011) (Order granting motion to dismiss in part and denying in part).
[582]Restatement (Second) of Torts' & § 519(2) (1979).
[583]Ibid part I.

before subjecting the kind of harm to a strict liability cause of action.[584] What this means is that water contamination harm related to fracking should be actionable under a strict liability theory because the possibility of it occurring is high from statistics and reviews of studies already analysed in Chapter V of this thesis.

For example, if a person working at a gas well broke an arm in the course of duty, strict liability would not apply because that harm is very rare in most drilling operations, and does not have a transgenerational impact, and that a broken arm can be remedied through medical expertise. Water contamination claims alone should be subject to a strict liability rule since it tends to have a transgenerational impacts on victims. Having said that, the following assertions shall be examined to conclude the argument.

6.5.2.1 Assertion 1: The Water Contamination Harm Attributable to HVHF is Significant both in Magnitude and in Likelihood

The court often evaluates whether an activity portrays "a high degree of risk of some harm to a person, land or chattels of others"[585] in order to determine an abnormally dangerous activity.[586] It then proceeds to examine the "likelihood that the harm that results from the activity will be great".[587] Immediately upon finding that the harm is major in degree and sufficiently serious, and that others are exposed to an unusual risk, the court is then justified to hold the defendant strictly liable.[588]

According to section 520 (a) and (b) of the Restatement, an evaluation of the magnitude and likelihood of the potential harm is required.[589] For fracking cases, the magnitude has the potential to be significant, considering the possible harmful nature of some of the chemicals used in fracking,[590] the incidental release of radionuclides into public water,[591] and the high volume of flow back water to surface water resources near shale wells. The value of residential real estate is lost without clean drinking water.[592]

The likelihood of the harm is also confirmed by the complex geological challenges that need to be surmounted prior to the safe fracking of a well.[593] There is knowledge of the likelihood of drilling accidents in the oil and gas industries, because there is no concrete guarantee that equipment will not fail.[594] These accidents and spills in most fracking sites suggest the real possibility that there are wells that have been poorly constructed. This is not to say that other oil and gas extraction techniques do not have the potential to contaminate groundwater. Rather when one compares fracking to other extractive techniques the likelihood is very high, and the chemicals used in other wells are not as hazardous as those used in the fracking process.

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[584]See supra Fiorentino V. Cabot Oil & Gas Corp footnote 579.
[585]*See* § 519 Cmt. E.
[586]See supra Sprankle v. Bower Amonia &Chemical Co footnote 464 (quoting Restatement § 520(A).
[587]Ibid at § 520(B).
[588]Ibid at § 520 Cmt. G.
[589]Ibid at § 520(A)–(B).
[590]*See supra* Part I.A.
[591]Judolf, C. J. (2011). Federal officials say they'll examine fracking practices, New York. [Online] http://www.green.blogs.nytimes.com/2011/03/03/federal-oecials-saytheyll-examine-fracking-practices/; press release, State University of New York at Buffalo, (Accessed on 29/06/2017)
[592]Bateman, C. (2010). A Colossal Fracking Mess, Vanity Fair (*- (June 21, 2010), http://www.vanityfair.com/business/features/2010/06/fracking-in-pennsylvania-201006. (Accessed 29/06/2017).
[593]See supra note 456 at 2.
[594]*See* Pioneer Natural Res. USA, Inc. V. W.L. Ranch, Inc., 127 S.W.3d 900, 907 (Tex. App. 2004). *See Generally Documents: Natural Gas's Toxic Waste*, (Publishing over one thousand pages of state, federal, and corporate documents that discuss fracking's potential risks).

6.5.2.2 Assertion 2: The Exercise of Reasonable Care Cannot Eliminate HVHF Risk

In order to shift from a negligence-based cause of action to strict liability, the evidence of a risk of harm is a must requirement despite the fact that reasonable care has been exercised by the defendant.[595] The phrase reasonable care might be elusive in interpretation. Thus, it is important to know the meaning of reasonable care. This term is closely related to the legal definition of negligence, generally defined as the failure to exercise the degree of care appropriate to a situation. However, whether a person has acted reasonably depends on the facts of the case. In addition, Black's law dictionary (1990) defined "reasonable care" as follows: "the degree of care that a prudent and competent person engaged in the line of business or endeavour would exercise under similar circumstance."[596]

The fact that shale fracking is quite a new process, and if the numerous environmental violations witnessed in Pennsylvania within a brief period are any indication,[597] companies are still finding it difficult to come up with what reasonable care is with respect to fracking operations. From the above definition, it is true to say that most of the contamination incidents are a product of the absence of reasonable care.[598] Consequently, there exists a plethora of research that infers that though wells might be fracked and drilled properly, there are possibilities for migration of methane, discharge of flow back, and contamination of aquifers to take place.[599] In conclusion, the lack of guarantee from drillers regarding freedom from accidents leaves one with no further option but to believe that even in the face of an exercise of reasonable care, preventing all accidents is still quite farfetched.

6.5.2.3 Assertion 3: The Slick Water Fracking Technique Fails the Common Usage Test and Probably Inappropriate to the Location Where it is Carried On

The next usual question to be determined from the Restatement comment is whether the activity in question is "a matter of common usage".[600] The term common usage simply means "customarily carried on by the great mass of mankind or by many people in the community".[601] A vivid understanding regarding the subject is necessary if one takes the example of driving a car as given by the Restatement's comments:

> "[A]*utomobiles have come into such general use that their operation is a matter of common usage. This, notwithstanding the residue of unavoidable risk of serious harm that may result even from their careful operation, is sufficient to prevent their use from being regarded as an abnormally dangerous activity. On the other hand, the operation of a*

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[595]Restatement (Second) of Torts & § 520(c) (1979); *See also* Industrial Harbor Belt R.R. Co. V. Am. Cyanamid Co., 916 F.2d 1174, 1177 (7th Cir. 1990) ("Sometimes, however, a particular type of accident cannot be prevented by taking care.").

[596]Garner, B.A. (2015). Balck's Law Dictionary. (10th ed., by Bryan A. Garner) p.255.

[597]Mocarsky, S. (2010). 'Report: Firms Commit 1,500 Infractions in Pa. In 30 Months, Wilkes-Barre Times Leader [Online] http://www.timesleader.com/news/hottopics/shale/report__firms_commit_1_500_infractions_in_pa__in_30_months_08-02-2010.html (featuring different opinions from land trust and industry officials on whether Pennsylvania should strengthen its regulations).

[598]Warco, O. K. (2010). Fracking Truck Runs off Road; Contents Spill, Washington Observer-Rep, [Online], http://www.observer-reporter.com/or/localnews/10-21-2010-fracking-truck-rolls (Accessed 2104/2018).

[599]Sawyer, H. (2009). Final Impact Assessment Report: Impact Assessment of Natural Gas in the New York City water supply watershed 49 *Available at* http://www.nyc.gov/html/dep/pdf/natural_gas_drilling/12_23_2009_5nal_assessment_report.pdf. (Accessed on 29/06/2017).

[600]Restatement (Second) of Torts § 520(D) (1979).

[601]Ibid at § 520 Cmt. I.

tank…is not yet a usual activity for many people, and therefore the operation of such a vehicle may be abnormally dangerous".[602]

Presently, the production of oil and gas deposits through fracking only takes place in very few countries. The US is taking the lead in this area. However, although a few states have engaged in fracking activities, others have placed moratoriums towards the extraction of gas from unconventional reserves through fracking pending proper investigations as to the health and environmental implications. Observe the words 'great mass of mankind' being used while defining what common usage is in factor 'e' under the Restatement Act. With the phrase 'great mass of mankind', it suffice to say that where slick water technique is used to produce gas qualifies for the 'common usage criteria' as earlier discussed in Chapter V.

The practice of this technique is still in its early stage, it probably has not yet "come into… general use," at least to the extent that automobiles have.[603] The world is a global community, and for slick water fracking technique to be seen as a process that has a common usage effect, the global community must be aware and have applied it towards the extraction of oil and gas resources for those countries that are endowed with hydrocarbons. As long as the USA is the only country that the slick water hydraulic fracking is making wave whilst other countries like China, Poland and the UK are yet to surmount the inherent environmental risks towards a sustainable shale gas extraction, it then means that the 'common usage' test is not yet fulfilled.

Having considered that, the inappropriateness of the activity to the place where it is carried out is the next factor for determination.[604] Take the following example: the impact of a missile does not ordinarily present an abnormal danger if it is located in the midst of a desert area compared to when it is fired into in a densely populated area.[605] Thus, it goes without saying that a court may not consider fracking as an abnormally dangerous activity if it were taking place in an area far from human settlement, with no opportunity to contaminate drinking water supplies.

In addition, appropriateness goes beyond where the activity is being carried out. Whether an activity is appropriate also depends on the type of technique that was adopted while other environmentally friendly options exist. There are other techniques with better and less health and environmental implications.[606] These techniques were not adopted by the industry due to the cost implications involved in operating them (as discussed section 2.6). Rather, the slick water fluid based hydraulic fracking technique was used because of the reduced operating cost associated with the technique. It follows from this that it is inappropriate too where alternatives that are better exist, yet an option whose deficiencies outweigh its merits was opted for by the industry on the premise that it was cost effective.

6.5.2.4 Assertion 4: It is False that Fracking Benefits Outweighs the Environmental and Public Health Risks

What is required of the court is to evaluate the degree to which the activity's value to the community surpasses the dangerous attributes.[607] This issue has called for great deal of deliberation among judges and scholars who argued against this assertion in the hope that

[602]Ibid.
[603]Ibid.
[604]Ibid.
[605]Ibid § 520 Cmt. J.
[606]See Chapter three, where the discussions regarding the various forms of fluid based hydraulic fracking exists and the advantages of each of these forms.
[607]Ibid at § 520(F).

regulations and liabilities for fracking be relaxed. This argument is anchored on the potential benefits fracking has brought to the US economy.[608]

However, looking at the nature of the oil and gas industry, it is true that these projects take place for only a short period of time.[609] The time frame for a well is dependent upon the commercial discovery for that well or wells. Thus, the said job opportunities and securities are tied to the life-span of the well. Issues like government regulation could lead to a slash in the workforce or a failure in the contractual work plan could lead to penalties from the host government. And to pay these penalties, there could be a reduction in the workforce or a commensurate forestalling of some sustainable development projects going on within the community.

Also, the value an activity might present to the immediate community is sometimes based on the health disposition of the individual at the time the companies are operating. Not all might benefit. In contrast, the environmental and health dangers an activity presents can be felt evenly by all within that community. Both young and old share somehow in the negative implications that activity causes. Everyone is forced to partake involuntarily. The effects of an activity's environmental dangerous impacts are communal in nature, whereas the benefits of the activity are not communal because they are based on certain reason such as choice and discipline and career line of people living around shale gas sites. For a detail arguments on these see section 5.8.5. The question is: Has the community been surviving without the oil and gas extraction activity's benefits? Yes!

6.6 Summary

Considering all the Restatement factors, it is not out of place to conclude that fracking in itself as a technique is not an abnormally dangerous activity. Consequently, it is pertinent to note that the Restatement comments do not necessarily require that each of the six factors in section 520 be fulfilled,[610] especially if others weigh heavily, and the weight of the factors is to be considered by the court.[611] However, just one of the factors is not considered to be sufficient, but a consideration of several of them will be determined before a strict liability doctrine can apply.

However, because of the kind of harm fracking presents, especially water contamination, it is the argument of this thesis that when it comes to water contamination as a course of action, strict liability should be applied as a viable cause of action in determining whether an activity's effect level is high. This argument makes sense because the value of the water to the community cannot be quantified with the benefits of jobs and investments presented by oil and gas extraction activities. Thus, in a way, fracking is not abnormally dangerous where there are no frequent water contamination claims. As long as the facts have been discovered that it is the defendant's activity that caused such contamination, proof of negligence is not necessary at all. Strict liability automatically applies only to water contamination but for other harm caused by fracking whose occurrence level is not high, these can be subject to a negligence cause of action.

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[608]See supra Crawford V. Hrabe, 44 P.3d 442, 453 (Kan. 2002) foot note 549, (Discussing the "economically beneficial" nature of the conduct and ruling in the driller's favour); Coastal Oil & Gas Corp. V. Garza Energy Trust, 268 S.W.3d 1, 26–30 (Tex. 2008) (Willett, J., Concurring) (Discussing the economic importance of fracking at length before concluding that the law of trespass should not apply).

[609]Usually based on the contractual agreement between the host governments and the IOCs.

[610]Ibid at § 520 Cmt. F.

[611]Ibid at § 520 Cmt. *L*.

Also, as discussed earlier, doubt remains regarding whether shale gas drilling and fracking can be carried out safely or that in locations where this activity take place, harm can be avoided even when oil and gas companies observe the utmost reasonable care. Far from reality, fracking may not become common and beneficial to a point where it can be exempted from strict liability as more fracking would lead to stricter environmental rules for mitigating the risks involved.

Chapter 7

7. Hydraulic Fracking: Policy Alternatives to Environmental Regulation for Mitigating Risks

It is no longer news that the limits to regulation governance is real and deeply entrenched in the ways that regulatory institutions handle environmental problems. Existing traditional environmental regulation appear to be built upon very conflicting relationships between governments, government agencies and enterprises. The era where environmental agencies' mode of operations is designed around enforcement through site visits to deter firms from inappropriate behaviours has got to end in a rapid changing industry like the energy extractive industry.[612]

Despite the important results realized so far from direct form of environmental regulation, this approach creates more difficult conflicts than strategies designed to survive on its own without a strict policing enforcement approach to achieve effectiveness in terms of compliance and risks mitigation. Self-sustaining strategies in environmental regulation governance builds cooperation, whereas the traditional style generates deadlock in decision making process and leads to parties with holding vital information.

This has made mitigating risk complicated because the major part of a regulator's efforts is now driven to penalise to either enrich the institution for further policing. Therefore, there is no distinction between firm's performances. This chapter seeks to explore multiple alternatives to foster improvements on compliance to achieve effectiveness in environmental regulation governance and to encourage already compliant companies to do what.[613]

Consequently, this chapter will suggest innovative proactive policy strategies to set new relationships between regulators and regulated firms based on trust building and focusing on responsibilities and commitment. Besides improving relationships, Chapter VII also aims to bring to attention other environmental governance limits that must be considered. This includes: promoting efforts which ends when compliance is met thereby favouring optimal solutions; and regulatory models which 'treats' instead of 'prevents' risks at the point of technology development. Therefore, possible ways to ensure and guarantee the pursuit of a full legal standard of legal liability will be explored here in order to push the overall objective of environmental governance efficacy to be preventive and later precautionary. Sadly, the reverse is the case in the present environmental governance structure.

7.1 Introduction

It is important to mention that the ability of a regulatory institution to address a public policy issue depends on how well it is tailored or adaptable to the nature of the underlying regulatory problems such as the interests involved and whether the risk is an acceptable one. This sparks off the very vital element which gives credence to this policy interventionist approach as well as nonconventional regulatory approaches which this thesis seeks to address in this chapter as it relates to managing and mitigating risks associated with shale gas development.

The attributes of legal institutions responsible for regulating shale gas development are significantly limited in their usefulness in prospectively regulating the risks of shale gas especially water contamination risks. Such attributes of regulatory agencies include the

[612]United States Environmental Agency/International Network for Environmental Compliance and Enforcement, (2009). Principles of Environmental Compliance and Enforcement Handbook. EPA 300-F-09-002 USEPA/INECE, Washington. http://www.inece.org/principleshandbook_23sept09.pdf [Available 21August, 2018].

[613]Fiorino, D. J. (2006). The New Environmental Regulation. MIT, Massachussetts.

limited budgetary constraints when it comes to its remedial powers in the event of environmental or health harm, and political constraints is another attribute of the regulatory bodies saddled with the obligation of regulating dangerous facilities.

Decisions and decision makers in such regulatory bodies are significantly subject to political pressure since they were appointed by politicians, or the politicians stifle their budgetary demands. Some legal environments and legal frameworks exempt most dangerous facilities from legal liability through existing legal legislation. This is exemplified by the famous 'Halliburton loophole' in the USA. As a result, regulation is limited by these exceptive provisions contained in environmental regulatory laws.

A key question at this juncture to ask is whether a liability approach has advantages over conventional regulation. Taking a cue from the classic work of Shavell (1984), he stated that liability approaches are advantageous to the extent that the four conditions already discussed in Chapter V are met. However, in the case of shale gas risks, widespread harms such as air and water pollution are difficult to address entirely through a liability system. Nevertheless, regarding other harms ranging from damage to private property or private water wells to truck accidents, liability systems can fill the vacuum left by traditional regulation.

It is upon this premise that this thesis shall proffer innovative policy interventionist as well as relevant nonconventional approaches for filling the gaps to addressing the risks associated with shale gas development. Thus, liability rules and policy approaches shall be deployed to address the gaps left by traditional regulation so that liability and regulation can operate effectively in a symbiotic parallel in addressing different risks and harms from shale gas development. Interestingly, this system comprises good principles for deciding whether liability or regulation is the best option of controlling risks. Though to decide that might be difficult, especially in individual cases, in a wider perspective, the present balance between liability and regulation tends to agree with those principles and policy options.

Hence, instead of stoking the already-controversial debates regarding whether additional regulation is required, it will make more sense to examine practical avenues for which the present system designed for managing and mitigating risks associated with shale gas development can be made more effective.

Therefore, policy interventions which will act as a complement and improvement in regulating shale gas development shall be broadly discussed analysed alongside innovative ingredients for improving the liability system given the significance of liability in managing and mitigating development risks and encouraging exercise of care by operators. Accordingly, this chapter will explore the gaps and the added incentives to improve upon the liability systems by way of complementing traditional regulation in addressing risks associated with shale gas fracking.

7.2 Information Asymmetry

Why does the shale gas industry enjoy some legislative exemption in some legal frameworks, for example in the US? Why the slick water HVHF preferred over other available fluid based hydraulic fracking techniques? Why are the chemical compositions of the chemicals being used for hydraulic fracking not voluntarily disclosed by operators? All the above questions are examples of industry existing arrangements that could be set in place to level information asymmetries.

Without mincing words, it is evidently true that individuals and organizations are privy to different information. Such information that they possess accordingly determines the conduct and actions they will respectively take in many circumstances. Considering the presence of

potential risks in shale gas development, for example, the operator adjusts the price of the resource extracted based on the level of risks they have been exposed to or their knowledge of the costs involved in producing the oil and gas as a commodity among other conditions. The buyer, in the same vein, can possess similar information of the risks the operator is exposed to during production from other operators of shale gas sites. However, what the buyer probably does not have, in contrast to the operator, is the level of information about the cost of extracting the oil and gas resources from the unconventional reserve. What this represents is a complete information asymmetry between the two parties, that is, the operator and regulator in risk management matters.

Asymmetric information as a concept was first introduced in George A. Akerlof's 1970 paper *The Market for "Lemons": Quality Uncertainty and the Market Mechanism.*[614] In the paper, Akerlof used examples of the automobile market to develop the concept of asymmetric information. He argued that in many markets the buyer uses some market statistics to evaluate the value of a class of goods. As a result, the buyer saw the average of the whole market while the seller of the goods had more intimate knowledge of a specific item. Therefore, Akerlof argued that it is because of the information asymmetry that the seller has an incentive to sell goods of less than average market quality.

Information asymmetry is otherwise known as imperfect information. It happens when there is a difference in access to relevant knowledge. Therefore, the whole essence of this concept is the key to managing shale gas development because a good understanding of the concept is key to successfully manage and mitigate the relevant risks. As operators of dangerous facilities and the potential victims invariably hold imperfect information about one another, it creates difficulty in understanding the risks involved too.

Linking this issue to shale gas extraction where a lot of information asymmetry exists from the stages of exploration to the actual extraction of these resources from deep underground by operators, the issue of risk management becomes a difficult objective to achieve when private actors have better access to information than regulators. Thus, liability is more effectual, all else being equal.[615] Thus, allowing wrongdoers to escape liability because of information asymmetry between the operators and victims can create problems whereby victims are neither aware they have been injured, cannot ascertain who is behind their injury, nor cannot acquire sufficient proof to substantiate their claim.

There is also the aspect of cost involved even in situations where such information can be obtained. Obtaining such information is difficult especially for widespread harms, like air and surface water pollution as already discussed in section 1.6. The challenge to locate and obtain this type of information's is also evident where harms are relatively localised, as in some cases of groundwater or soil contamination. Having said that, it is imperative to examine some of the innovative policy intervention option designs for the effective operations of regulatory and liability approaches to manage problems of information asymmetry associated with shale gas development activity and improve the function of liability systems as a complement to traditional regulation.

7.2.1 Disclosure Intervention Option

If the idea of compulsory disclosure of information would be encouraged through policy making, it will go a long way in addressing the issue of information asymmetry in shale gas

[614]Akerlof, G A. (1970). The market for "lemons": Quality uncertainty and the market mechanism; *The Quarterly Journal of Economics* 84(3):488–500.
[615]See supra Shavell, S. (1984) footnote 288 pp.274–76.

development where levels of expertise between operators and potential victims differ immensely. Once this is achieved through policy intervention, the resultant effect is that there are beneficial changes in firm's behaviour[616] such that they become more careful because members of the public become aware of the 'do's and don'ts' of the business of shale fracking through slick water hydraulic fracking. This also impacts on the choice of technology to use for such activities. This is true because, as already analysed in section 2.6, that among the alternative fluid based hydraulic fracking techniques, the industry opted for the slick water hydraulic fracking technique, the reason being that it is cost effective compared to other techniques at the expense of the health and environmental implications it presents to society in general. Thus, a strong disclosure governance arrangement for the development of shale gas from unconventional reserves will further strengthen the liability system and make regulation more effective in reducing risks associated with shale gas fracking.

In addition, disclosure rules and requirements equip prospective plaintiffs with information in legal action. For example, victims of groundwater contamination would be able to access information to strengthen their case due to an already existing requirement that firms report spills and such other accidents, waste water transportation tracking and record keeping or even disclose the make-up of the chemicals used for fracking regulations: all can assist victims to identify and sue operators or those indirectly involved for the environmental damage.

With such disclosure requirements, it would further curb the practice of mother companies incorporating smaller subsidiary companies to do the work so that in the event of damage, the smaller company can claim to be judgement proof as their available assets cannot cover the damage in question. But disclosure requirements can even recover such differences from their mother company since the law recognises the notion of judgement creditors suing the estates of a wrongdoer to recover damages in full for any environmental damage caused.

Thus, where there are no such rules for disclosure, it may be difficult or impossible for such litigation to thrive. Although civil discovery can prove helpful for plaintiffs to uncover information, the route to acquiring such information might be costly for both the operator and the victims.[617]

However, the requirements and rules for compulsory disclosure has generated very controversial debates. One such argument that the opponents of this policy intervention have always advanced centres on proprietary rights protected by law. The question is how victims of accidents would take advantage of such disclosure requirements other than protecting themselves from the negative impacts of dangerous risky activity. Therefore, proprietary rights protection is only limited to parties within the same industry who provide the same goods and service. As in the business of shale gas fracking, it is limited to those in the business of extracting oil and gas from both conventional and non-conventional fields.

Technically, the disclosure requirements and rules gain more credence in that once everybody within the shale gas industry is made to disclose, for instance, the chemical make and the types they use, there will be no more secrets between participants in that industry. So, it would be a case of access to better practice as industry participants would be able to truthfully state the dangers that those chemicals present and warn against them. Also, there will be eventually unanimous agreement on which chemicals are environmentally friendly contra some

[616]Bennear, L. S & Olmstead, S. S. (2008). The impact of the "right to know": Information disclosure and the violation of drinking water standards. *Journal of Environmental Economics & Management* Volume 56, pp.117, 120, 129.

[617]Yeazell, S. (2004). Getting what we asked for, getting what we paid for and not liking what we got: the vanishing civil trial, UCLA Pub. l. & Legal Theory Series, Oct. 10, 2004, at 6, 8, 12–14.

participants hiding behind the guise of proprietary rights and using chemicals that have the capability to contaminate groundwater and surface water.

7.2.2 Shifting the Burden of Proof Option

Another option available in addressing the issue of information asymmetry existing in the shale gas sector that frustrates the ability of traditional regulation to mitigate associated risks is the proposal for a shift in the burden of proof to the defendant operator in litigation. The requirement should replace or run concurrently with the rule for pre-testing of water wells near drilling operations to identify groundwater contamination as it is for most states in the US.[618]

Such reports could be influenced and compromised by very big oil firms due to their affiliations with regulatory officials responsible for conducting such pre-testing exercises. The report would reveal a high concentration of the compounds similar to that deployed in fracking operations. But where the burden of proof is shifted to the defendant operator in order to exonerate them from liability it would serve to force operators to use chemicals or even force them to adhere to the best available practices during their operations.

Pennsylvania, for example, does not require pre-testing of groundwater near drilling sites but shifts the burden of proof to the operator if such testing is not done.[619] This shifting of burden of proof is sound in the sense that the operator is privy to information regarding the quality and other geological and hydrological conditions that the victim does not have access to on the one hand. On the other hand, even where a pre-drilling water test is carried out, it might not be a fair and accurate report of the event of things, because if not for the fact that shale gas extraction activity commenced near the plaintiff's property, the question of contamination would not have arisen definitely in the long run.

Thus, it can be inferred circumstantially that shale gas was responsible for the change of affairs. Once this option of shifting burden of proof is imposed, the liability system would function more effectively as beneficial changes to the behaviour of the operator would be guaranteed to a large degree. More so, there is the likely chance of reducing the litigation costs, decreasing the room for a wrongdoer to escape liability for the mere reason that the plaintiff could not link causative events, and cases would be decided expeditiously and timely.

This option of shifting the burden of proof is also advantageous to the operator because they get the opportunity to improve the confidence of victims when they succeed in proving that their activities did not cause the alleged complaint of groundwater contamination, thereby getting the social license to operate within the immediate society. Again, litigation becomes a cheaper alternative to traditional regulation as resources meant to police these firms would be used for other developmental projects and operators are meant to do the spending to prove a disconnect between the alleged accident and their activity.

7.2.3 The Imposition of Strict Liability Policy Intervention

The classic English case of *Ryland's V. Fletcher*[620] can be said to be the very root in which strict liability can be traced. In Ryland's case, a reservoir containing water was constructed on land owned by the defendant.[621] These underground mines cut across the newly constructed

[618]Ohio Administrative Code 1501:9-1-02(F) (2014) (Requiring sampling of all wells within 300 feet prior to drilling).
[619]58 PA. Cons. Stat. § 3218 (2012).
[620]Rylands V. Fletcher, L.R. 3 H.L. 330 (1868); Jones W. K, (1992). Strict liability for hazardous enterprise, 92 column. L. Rev. 1705, 1709 (detailing how *Ryland's case* established the strict liability doctrine).
[621]Rylands, L.R. 3 H.L.at 331–32.

reservoir.[622] Immediately upon the reservoir being filled with water, it flowed through the abandoned mines into the defendants functioning mines thereby causing their destruction.[623]

From the facts of the case, the court realised although that the defendants were not negligent in constructing a reservoir on their land, according to the strict liability rule they were still liable.[624] The decision of the court in the above case was that where a land owner brought something onto the land which ought not to be there, that thing becomes a danger irrespective of whether the defendant acted with all due diligence.[625] The land owner was automatically liable in damages for any resultant harm, whether or not the behaviour was deliberate or negligent.[626] The rationale behind the decision goes to show that while certain activities are ideal under certain jurisdictions, they are not fit to be carried out everywhere.[627]

Nonetheless, the Ryland case set a landmark precedent in England; however, this was contrary to the situation in the US.[628] The US courts resisted the rule of strict liability reason being that it has the potential of inhibiting expansion of developmental projects as it provided damages to harmed plaintiffs.[629] What the US courts did was to have a kind of a restrictive strict liability rule such that defendants were liable only on grounds that the plaintiffs sustained injuries as a result of the defendant's actions.[630]

One other reason why many courts ignored the analysis in the Ryland case was due to the interpretation the courts had that defendants are "absolutely liable in all ramifications whenever anything subject to his control, escapes and results to harm".[631] This was a narrow interpretation and has been overtaken by events environmental regulatory reforms in the status of the legal framework of any nation. For example, harm caused by the actions of a third party where the defendants had satisfied all reasonable care requirements within the normal business activity, such harm cannot be transferred to the defendant in liability. Nevertheless, the way some writers understood the Ryland case is different. According to Prosser, liability should be borne by the defendant when his actions cause damage to another because the thing or activity in question is inappropriate to the location where it is maintained, in line with the character of the location and its surroundings.[632]

Today, the doctrine of strict liability regarding abnormally dangerous activities formulated in the Restatement of Torts are followed by most courts.[633] When the doctrine of strict liability for abnormally dangerous activities was still confined to the Ryland rule,[634] Professor Francis Bohlen reported the Restatement of Torts in 1938.[635] A comparative broad rule of strict liability was proposed by Professor Bohlen in the Restatement despite this fact.[636] This rule

[622]Ibid.
[623]Ibid.
[624]Ibid at p.340
[625]Ibid.
[626]Ibid.
[627]Boston, W. G. (1999). Strict Liability for Abnormally Dangerous Activity*:* The Negligence Barrier, *San Diego Law. Review*. Volume 36, pp.597, 604.
[628]See supra note 96 p.1709. Two U.S. jurisdictions accepted *Ryland's*, but then in the 1870s New York, New Hampshire, and New Jersey refused to follow this principle.
[629]See supra Word Bank. (2000) footnote 89 at p.537.
[630]See supra Organization for Economic Co-operation and Development, (1995) footnote 95 at p.1709.
[631]See supra European Environment Agency, EEA s/d. Paper1 (2002) footnote 101 at 604.
[632]Prosser W. L., (1953). The Principle of Ryland's V. Fletcher*,* In: Selected topics on the law of torts 135, 147.
[633]Klass, A. B. (2004). From Reservoirs to Remediation*:* The impact of CERCLA on common law strict liability environmental Claims, *Wake Forest Law. Review.* Volume 39, pp.903, 904–05, 925–26 at p.912.
[634]See supra European Environment Agency, EEA s/d. Paper1 (2002) footnote 101 at pp.604-05
[635]Ibid.
[636]Ibid.

called for strict liability for "ultra-hazardous activities".[637] Two necessary elements constitute ultra-hazardous activities.[638] First, under these elements, the said activity must involve a phenomenon that even the exercise of utmost care cannot eliminate the risk of serious harm to persons, chattels of others, and lands.[639] Second, for it to qualify as an ultra-hazardous activity, it must not be a matter of common usage.[640] Imperatively, activity is classified as ultra-hazardous if the risk of harm does not justify or outweighs the utility.[641]

However, the Ryland rule is shorter in scope than Bohlen's ultra-hazardous standard in two pertinent respects.[642] The test in the Ryland rule regarding the non-natural use element gave room for the "matter of common usage" ingredient of ultra-hazardous activities.[643] The common usage provision created an outcome where the principle of strict liability was extended to activities not usually undertaken by the great mass of mankind.[644] Second, the limited definition of land in Ryland's case was further expanded as a result of the ultra-hazardous principle.[645] In the Ryland case, the defendant's liability was only limited to adjacent landowners.[646] In contrast, the defendant's liability extends to any person affected by his use of dangerous instrumentalities or activities.[647] Consequently, the sharp difference between the Restatement Act was that, for an activity to qualify as "unavoidably" dangerous, such activity must be that it involves a risk that cannot be eradicated by the exercise of the utmost care.[648]

Essentially the current position of strict liability can be traced to the *Restatement (Second) of Torts* that incorporates the historical foundations. The Second *Restatement* postulates that liability for harm lies with one who undertakes an abnormally dangerous activity regardless of whether utmost care has been used to avoid such harm.[649] Therefore, to conclude whether strict liability should apply to an activity is dependent primarily on a conclusion that that activity is abnormally dangerous. Accordingly, the Second Restatement has identified six factors which this thesis had earlier deliberated in section 5.8.1 to 5.8.5.[650]

Those six factors were used by the drafters of the *Restatement* based on the premise that they did not agree that it was possible to arrive at an all-encompassing definition of what an abnormally dangerous activity is sufficient to cover every potential case.[651] In addition, two pertinent points were clarified following the comments that accompanied the Restatement: (1) whether the activity is carried on in pursuit of profit or pleasure does not make a difference;[652] and (2) the rule of strict liability is not restricted to the defendant's land; the activity could also take place on public land.[653]

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[637]Restatement of torts § 519 (1938).
[638]Restatement of torts § 520.
[639]Restatement of torts § 520 § 520(A).
[640]Restatement of torts § 520(B).
[641]Restatement of torts § 520 Cmt. A.
[642]See supra European Environment Agency, EEA s/d. Paper1 (2002) footnote 101 at 605–06.
[643]See supra European Environment Agency, EEA s/d. Paper1 (2002) footnote 101 at 605.
[644]Restatement of torts § 520 Cmt. E.
[645]See supra European Environment Agency, EEA s/d. Paper1 (2002) footnote 101 at pp 605-06.
[646]See supra European Environment Agency, EEA s/d. Paper1 (2002) footnote 101 at 605.
[647]Restatement of torts § 520 Cmts. B–D.
[648]Restatement of torts § 520(B).
[649]Restatement (Second) of Torts § 519(1) (1977).
[650]Ibid.
[651]See supra European Environment Agency, EEA s/d. Paper1 (2002) footnote 101 at p.620.
[652]Restatement (Second) of torts § 520 Cmt. D (1977).
[653]Ibid at 520 Cmt. E (1977).

In as much as these six factors are necessary and need to be taken into cognisance, the strict liability rule need not require that each factor ought to be present before arriving at a final decision.[654] From the decisions of courts, factors (a), (b), and (c) have been treated by many courts as a priority to the analysis. However, the other factors ((d), (e) and (f)) have been applied inconsistently depending on the complexity of each case.[655] What this implies is that the threshold for distinguishing negligence from strict liability lies on the first three factors, as they address the question of whether reasonable care eliminates the risk of the activity in view.[656] More weight is put on the first three factors because the last three factors allow for a substantial amount of judicial discretion as they are based on facts presented.[657] The big question is whether the danger(s) created by the activity and the location of where the activity took place are so glaring and great that, despite any contributions the activity brings to the community, the defendant "should be expected as a matter of law to pay for any harm it creates" without negligence being proved by the plaintiff.[658]

At this juncture, it is important to state that strict liability is the most common approach in addressing information asymmetry in litigation, that is, liability without determining whether a defendant has exercised due care in the course of carrying out said operations. Traditionally, the principle is applied to ultra-hazardous activities, on the rationale that such activities involve a very high standard of duty of care.[659] For example, in a few states in US, the principle is applied to oil drilling as this activity is classed as ultra-hazardous,[660] but in others, the negligence standard[661] is the rule for which the courts handle drilling related matters.

Surprisingly, many instinctively believe that imposing strict liability should result in a beneficial attitudinal change whereby operators will take additional care.[662] However, one vital advantage that strict liability exudes is in its ability to simplify litigation. This is true in that plaintiffs, in suing defendant operators, always find themselves unable to prove that the defendant exercised due care for the reason being that they are not well equipped with adequate information. What the strict liability rule then does is to empower the plaintiff to only prove they suffered injuries and that the defendant caused the so-called injuries.

Again, the concept of imposing strict liability affects the level of activity as, on the one hand, some will simply not engage again since they are subjected to greater liability. On the other hand, it can compel those who intend to engage in risky activity to choose the best technique from the available repertoire.

In relation to shale gas development techniques, as already examined, it will make operators go back to the drawing board to see how they can improve on the best fluid based hydraulic fracking technique. This may turn out to be good considering the information asymmetry syndrome on the part of the plaintiffs or the issue of the existence of judgment-proof

[654]Ibid at 520 Cmt. F (1977).
[655]See supra Commission of the European Communities, COM 2005) foot note 102 at p.622.
[656]See supra Word Bank. (2000) footnote 89 at p.543.
[657]Ibid.
[658]Ibid at pp.541–42 (Quoting Margie Searcy-Alford, A guide to toxic torts § 27.06[2] (2006)).
[659]Neal J. Manor, (2012). 'What the frack?" Why hydraulic fracturing is abnormally dangerous and whether Courts Should Allow Strict Liability Causes of Action, 4 KY. J. Equine, Agric. & Nat. Resources L. 459, 468–71
[660]*See* Franks V. Indep. Prod. Co., 96 P.3d 484, 492 (Wyo. 2004) ("Wyoming law recognizes that the drilling of an oil and gas well is an ultra hazardous activity").
[661]*See* Turner V. Big Lake Oil Co., 96 S.W.2d 221, 225–26 (Tex. 1936) (Declining to apply strict liability doctrine to oil drilling).
[662]Shavell, S. (1980). Strict Liability versus Negligence, 9 *Journal Legal Studies*. Volume 1, pp.7–8, 11.

defendants. When operators simply choose not to engage again or revert to the best available technique, it simply reveals that the activity levels of harm are greater than socially optimal.

7.2.4 Appointment of an Independent Well Assessor

As the name implies, an assessor is one who critically assesses the progress and effectiveness of a given assignment or task to see that it is going on as planned. An assessor is mostly required for professionals or regarding a specific project. The duty in most cases is for the assessor to supervise the candidate and monitor them to ensure that everything is taking place in line with the laid down rules and regulation stipulated by the admitting institution. The assessor makes sure that they delivers workshops and training programmes, observe professionals at the sites or the project at the site, record the progress of the work, attend meetings and examine portfolios.

To deal with information asymmetry in shale gas development, there is a need to appoint an independent assessor. The assessor in this concept must be independent to guarantee a fair and constructive assessment of the operations of shale gas activities within an area to see whether operators are adhering to the required safety standards while carrying out their activities.

This assessor is to be appointed by the regulatory institution/agency but financed by the oil firms in terms of remuneration. Their removal should never be subject to the whims and caprices of the firms even though they pay them. Rather it should be determined by the institution that appointed them. This is important because if it was the other way around, their reviews and assessments would be tainted.

Also, the findings and observations of the expert assessor should not be subjected to a confidentiality rule especially when victims of shale gas extractive accidents require it to prove whether a defendant operator has acted without due care. What this mean is that either party to a suit can take advantage of the findings of these expert evidences report and prove their case where necessary.

If these palliatives are put in place through policy recommendations, the resultant effect is that firms would become weary in acting or engaging in activities that are beyond the socially optimal level of risk and further boost the motivation for victims of shale gas accidents who suffer harm to sue because the possibility of securing environmental justice is not far-fetched.

7.3 Inability to Pay/Judgment Proof Defendant Problem

This challenge often is applicable to a liability system's approach of environmental protection. It is also true that policy makers are fully aware of the resultant problems whereby reliance on the liability system to take care of the possible damages falls through. This arises where the defendant's available assets cannot compensate the victims of their wilful negligent acts or actions. This situation is so prevalent in the oil and gas sector in the sense that damages from failed fracking wells or water contaminations can be to the extent that many independent firms operating within the industry cannot compensate the victims of such catastrophic event(s) with their limited resources.

In most cases, financial responsibility has been the traditional tool used to address these challenges inherent in liability systems. Some such financial arrangements includes insurance policy and bonding. The policy options to address the problem include the Insurance Policy and Bonding Financial Requirement Option and the Polluter Does Not Pay Model Policy Intervention. Both will now be discussed in the subsequent sections.

7.3.1 Insurance Policy and Bonding Financial Requirement Option

When an operator applies for a permit to drill and exploit natural resources within a potential well, the operator is required to furnish evidence of adequate financial capabilities or insurance agreements to prove its ability to pay for related claims that may arise in the event of mishaps resulting in harm.[663]

Further, bonds may be required to be posted by operators alongside the permits. Pennsylvania, for example, requires operators to file a bond of US$4,000 for each well permit.[664] Alternatively, operators in Colorado can file a 'blanket bond' of US$25,000 covering all wells in the state for that oil company.[665] Similarly, Texas requires a US$25,000 blanket bond for up to ten wells.[666]

When funded appropriately, bonding produces the required incentive of reducing the ability of operators with limited resources to escape liability and thus increasing the ultimate incentive to take due care to avoid harms. An amount of US$400 in bond is certainly inadequate to take care of the expected damages from serious accidents arising from oil and gas wells. Where the case is that the available firm's assets is far less than the damage, it provides the likely impetus on the part of the operator not to take additional care.

In the same vein, a US$25,000 blanket bond will also appear insufficient considering that large operators may have thousands of wells in their overall portfolio. Therefore, a stronger and extended financial responsibility requirements can improve the ability of the liability system to generate enough incentive for operators to take due care and avoid practices such as floating smaller independent companies for the sole purpose of appearing judgement proof when they are pronounced liable in damages by the court of a competent jurisdiction.

Because of the above, this thesis shall develop a model in addition to the insurance and bonding requirements and to further boost the effectiveness of the liability system in conjunction with traditional regulation. This model was carefully studied from Indian environmental law about the specific problems associated with environmental litigation and liability issues. The judiciary in India has evolved a new method of approaching environmental tort through public interest litigation which includes the state authorities in the process of regeneration, compensation and relief. The proactive nature of this method makes it unique and has also been lauded in India and attributed to the Indian judiciary. This thesis therefore, propose a Model like that of the Indian judiciary which has already been implemented in several cases. This Model is known as the Polluter Does Not Pay Model Policy Intervention and will be discussed in more detail below:

7.3.2 The Polluter Does Not Pay Model Policy Intervention

Before considering the legal and moral rationale behind the development of this Model, it is pertinent to briefly discuss the factors that led to the incorporation of this Model in the legal framework in India. The Indian judiciary deemed it necessary in the face of over-legislation and under-enforcement which resulted in the unprecedented degradation of cities and rivers in India and it became a special interest for the Indian judiciary in terms of social justice as thousands of poor Indians were dying of respiratory diseases as a result of drinking

[663]U.S. Environmental Protection. Agency, Federal financial responsibility demonstrations for owners and operators of Class II Oil-and gas-related injection wells 3–6 (1990), *available at* http://www.epa.gov/r5water/uic/forms/ffrdooc2.pdf. (Accessed 14/06/2018).
[664]58 PA. Cons. Stat. § 3225 (2012).
[665]2 Colo. Code Regs. § 404-1:703 (2014).
[666]Tex. Nat. Res. Code Ann. § 91.1042 (West 2005).

contaminated water. This continued for a long time because the victims of such environmental degradation had no individual financial capabilities to sue the polluters.[667]

The usual remedy which is typical also in the USA is class action tort. The claims for various individuals who are affected by accident impacts is consolidated in order to reduce the cost of litigation for each individual in the group. Although Indian law allows for a class suit or a representative suit, whereby one or more members in a class group having the same interest may sue or defend on behalf of themselves and for others,[668] it has been used in very few cases and with little success.

In response to the bias against the poor and the chronic delays evident in the legal system in India, the judiciary resolved to come up with a different route that will enable victims to seek legal remedy from polluters. This legal remedy was exemplified as the Supreme Court recognised the right to a clean environment as part of the fundamental right to life under Article 21.[669] This further opened up the floodgates for such environmental cases by allowing the cases to be filed as writ petitions.

The Indian State High court can be approached under Article 226 of the Constitution if the complaint is of a legal wrong. However, where any of a person's 'fundamental rights' are violated, they can approach the High Court, or the Supreme Court as contained in the fundamental rights chapter of the Constitution under Article 32.[670] Hence, the Supreme Court is viewed as the enforcer of fundamental rights coupled with its plenary powers to address cases which in its opinion passes as a Public Interest Litigation.[671]

Due to the above, the *locus standi* requirement for petitioning the Courts was diluted by the Supreme Court. What this means from a legal stand point is that it is not limited only to the victim to petition himself, but it extends to any public spirited individual to sue for legal remedy on behalf of disadvantaged classes or a member of a disadvantaged group (who in every sense is unable to approach the court himself due to his financial incapability).[672]

The Supreme Court in the case of *MC. Mehta v. Union of India* held that environmental pollution and industrial hazards were not only potential civils torts, but included violations of fundamental rights, entertained through the Supreme Court by a public interest petition under Article 32. This case eventually necessitated the need for the Supreme Court to assume jurisdiction with respect to a wide range of environmental cases using the writ of mandamus and intervened in cases such as pollution from tanneries,[673] pollution caused by chemicals in

[667]Craig, P. P & Deshpande, S. L. (1989). "Rights, Autonomy and Process: Public Interest Litigation in India" *Oxford Journal of Legal Studies*, Volume. 9, No. 3, autumn, pages 356-373, downloaded From Jstor at http://www.jstor.org/stable/764422 on July 29 2008.

[668]Order 1 Rule 8 of the Civil Procedure Code of 1908.

[669]Article 21 states 'no person shall be deprived of his life or personal liberty except according to procedure established by law'. The narrow interpretation of this right was that that the state had to demonstrate only that the interference with the individual accorded with the procedure laid down by properly enacted law. However, the Supreme Court intended to give substance to this fundamental right as opposed to interpreting it in a narrow procedural manner. Therefore, the right to life now extends to many other rights such as; right to livelihood, rights of slum dwellers and hawkers, right to medical care, right to shelter, right to education, right to food, right to privacy, right to a clean environment, and other socioeconomic rights.

[670]Jain, M P. (2005). "Indian Constitutional Law" Wadhwa & Company Nagpur, New Delhi India.

[671]See supra Craig, P. P; & Deshpande, S. L. (1989) footnote 667

[672]SP Gupta V Union of India 1981 Supp SCC 87.

[673]Vellore Citizens Welfare Forum V. Union of India (1996) 5 SCC 647.

Delhi,[674] Ganga River water pollution case,[675] Taj Mahal Pollution case,[676]Yamuna Rivers water Pollution case,[677] ban on import of toxic waste case,[678] pollution due to H Acid case,[679] Gomti River water pollution case,[680] noise pollution by fire cracker case,[681] pollution by chemical industries in the Gajraula area case,[682] mercury pollution in Singrauli case,[683] diesel generator set case,[684] modernisation of slaughter houses in Delhi matter,[685] of regulation traffic in Delhi,[686] regulation of Garbage disposal in Delhi matter,[687] coupled with other issues regarding the environment.

The Model is illustrated in various cases where the Supreme Court has resolved to entertain writ petitions against the government for violating the fundamental right to a clean environment due to government's inability and failure administratively. The Court gave direct and precise instructions to the government authority by the writ of mandamus to take steps in order to mitigate the pollution and redeem the environment. A corresponding order and notice is issued by the government authority to the various polluters for the purposes of claiming damages and restoration costs for the same.[688]

Thus, the Model works in India because the basic conditions are fulfilled by the Constitution empowering both the Federal and State Government to preserve the environment including the relevant authority reposed on them to do same by various environmental legislation like the Water Act of 1972, Air Act of 1963 and the Environmental Protection Act of 1986. The first such basic condition is that the government should have the authority and resources to pay interim relief and damages and shoulder the costs of environmental restoration. Second, the government must have the legal power to recover the money from the injurer. Having seen the factors that necessitated this Model as well as the conditions that must be present in order for the Model to succeed, it is now imperative to look at the rationale behind the formulation of the Model by the Indian judiciary.

The idea of making the State responsible for the damages is representative of a communal liability system and a more sophisticated group liability structure. This of course is not a new interventionist phenomenon and in fact precedes the "state itself. From historical antecedents, remedies of such communal compensation and retaliation for wrongs were prevalent in primitive societies. Just as Posner posited in his paper on the theory of primitive societies that the pertinent thing is that the harm and the responsibility are borne collectively,[689] what this

[674]M.C. Mehta V. UOI & Others Writ Petition (Civil) No.4677 of 1985.
[675]M.C. Mehta V. UOI & Others Writ Petition (Civil) No. 3727/1985.
[676]M.C. Mehta V. UOI & Others Writ Petition (Civil) No.13381 of 1984.
[677]AQFM Yamuna V Central Pollution Control Board (2000) 9 SCC 499.
[678]Research Foundation for Science Technology National Resource Policy V. Union of India and Anr. (1999) 1 SCC 223.
[679]Indian Council for Enviro-Legal Action V Union of India AIR 1996 SC 1446.
[680]Vineet Kumar Mathur V. UOI & Others (1996) 7 SCC 714.
[681]In Re Noise Pollution - (2005) 5 SCC 733.
[682]Imtiaz Ahmad V. UOI & Ors. Writ Petition (Civil) No.418/1998.
[683]M.C. Mehta V. UOI & Others I.A. No. 343/2000 In Writ Petition (Civil) No. 3727/1985.
[684]The United Communist Party of India V. The Union of India & Ors. CWP No.1640/2001.
[685]Buffalo Traders Welfare Association V Union of India & Ors. (2004) 11 SCC 333.
[686]Hemraj & Ors. V. Commissioner of Police & Ors CWP No.3419/1999 in the High Court of Delhi
[687]B.L. Wadhera V Union of India and Ors. (1996) 2 SCC 594.
[688]See Cases Andhra Pradesh Pollution Control Board V Prof MV Nayadu (1999) 2 SCC 718; Indian Council for Enviro-Legal Action V Union Of India Air 1996 SC 1446; Vellore Citizens Welfare Forum V Union Of India (1996) 5 SCC 647; Obayya Pujari V Member Secretary KSPCB Air 1999 Kant 157; BL Wadhera V Union of India (1996) 2 SCC 594; FQFM Yamuna V Central Pollution Control Board (2000) 9 SCC 499; MC Mehta V Union of India (1987) 4 SCC 463.
[689]Posner, R A. (1980). "A Theory of Primitive Society, With Special Reference to Law" *Journal of Law And*

illustrates is that in the social order and norm, if one person kills another, the victim's kinsmen have a duty to him which they can discharge by killing either the killer or one of his kinsmen in the retaliation stage. The killer's kinsmen are obligated to provide compensation for the killer if the killer is unable or is not willing to do so.

If neither the killer nor the kinsmen provide the required compensation, the victim's kinsmen then have the duty to retaliate against the killer or his kinsmen by punishing them for their refusal to compensate. This kind of practice may seem abhorrent to modern sensibilities but may be efficient in the conditions of primitive societies. The killing of any of the killer's kinsmen is fair game to the victim's kinsmen avenging his death, or in the later stage of development, that the killer's kinsmen are communally liable to the victim's kinsmen should the killer refuse to provide compensation that is due from him, gives the killer's or potential killers kinsmen an incentive to control his conduct.

Thus, they can also decide to kill him themselves to avoid any danger to themselves. Technically, they have the highest inkling to weed out potential killers in their midst for the sole purpose of averting the costs in retaliation or compensation should they be keeping a killer. Moreover, the killer is not often the initial target of retaliation from the victim's kinsmen and the knowledge that the sanction might not ultimately rest on the killer increases the incentives on the part of the killer's kinsmen to turn him in for punishment.[690]

These so-called primitive communal liability and compensatory methods are strong motivators for extracting information;[691] they create motivation for the society to monitor the injurer and prevent injury. The Ybarra Case, for instance, illustrates a situation where a patient was able to recover compensation from a few doctors and nurses for injury caused during an operation despite that point that the actual injurer was not identified. In this case, the fellow medical practitioners in the room were unlikely to testify against one another for the negligent act of one of them. The fact showed that one unidentified defendant was responsible for the injury and the court saw that it would be entirely impossible for the patient to recover damages unless the doctors and nurses in attendance voluntarily chose to reveal the identity of the negligent practitioner.[692]

Indeed, the effects of this kind of judge-made law is that it is an efficient tool for extracting information as well as an avenue for members of the community to reduce injuries and to identify the injurer sometimes prior to the injury. This can be ultimately advantageous for activities that produce dispersed harms over a group of people and where the causation is often difficult to determine, particularly in the case of shale gas developmental environmental tort cases.

The same idea of a communal liability and compensatory system can also be invoked in the case of environmental degradation associated with shale gas development due to the unknown and dispersed nature of harms, the difficulty of identifying the source and the operator responsible for certain accidents. Thus, it is the belief of this thesis that the liability system playing a complementary role in mitigating risks associated with industrial activities with such high frequency level for harm will have its intended effects if the government, being the

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Economics, Vol. 23, No. 1, p.1-53, downloaded from jstor [Online] http://www.jstor.org/stable/725284 on august 6 2008 (Accessed 23/05/2018).

[690]Ibid at p.44.

[691]Saul, L. (2008). "Gomorrah to Ybarra and more: over-extraction and the puzzle of immoderate group liability" *Virginia Law Review,* Volume. 81, No. 6, September 1995, page 1561-1604, downloaded from jstor at http://www.jstor.org/stable/1073532 on June 30.

[692]Ibid.

modern representative of the state, shoulders the cost of damages and the cost of restoration with taxpayer money then recovers same from the defendant operator subsequently by all means necessary.

For this proposition to work the following assumptions and conditions must be present. The first and most important is that no oil and gas firm whose assets in total cannot conveniently internalise the cost of potential pollution or environmental degradation should be allowed to carry out any extraction activities without an affiliate company whose assets can internalise the costs of potential environmental degradation. If this is made a requirement at the point of applying for a permit, and a clause is included empowering government to pursue the affiliated company to recover damages where the smaller independent company cannot internalise the cost involved, it completely addresses the notion of firms being judgment proof because government can still proceed against the affiliate company. Second, anyone financially capable should have the *locus standi* to sue the defendant operator for the damage caused to avoid the issue of rationale disinterest associated with environmental litigation.

7.4 Threat to Suit

Shale gas development is known for evidencing diverse risks just like some human industrial activity. Some harms from shale gas might be traceable to one operator. For example, an explosion from a shale gas site or a truck accident can be attributed to one shale gas operator. These kinds of incidents can make suits by plaintiffs easy to identify to start commencement of legal action.

However, there are some harms that are disparate in nature in terms of which operators amongst a number of different operators are responsible for the harm. Such disparate harm range from air pollution and surface water pollution to accumulated surface water contamination or pollution. This kind of disparate nature of harm often turns out to be a disincentive for the plaintiff in terms of legal action but turns out to be an incentive to the defendant operator in that they expect to escape suit for harms they may have caused. As a result, the incentives to reduce risk on the part of the operator by observing all necessary available approaches in carrying out this activity are not an urgent requirement. The operator does not have to self-regulate because they believe they might not be solely responsible for the air or water pollution around their shale gas site.

This often accounts for the source of the appeal for most oil and gas regulations. Regrettably, no sophisticated policy can change this disparate nature of risks associated with such oil and gas operations. Nevertheless, the effectiveness of a liability system to tackle the disparate nature of such risks which often lead to a reduced threat of suit can be improved upon through some changes in policy planning.

As this work is about proffering policy intervention options to mitigate risks of shale gas operations, it is important to identify and discuss some policy changes that can be implemented to address the problem of threat to suit associated with the ineffectiveness of liability and regulatory systems.

7.4.1 Segregated Licensing Scheme Option

The dispersed nature of risks in relation to shale gas development operations exemplifies the gap in regulation in practical terms. This dispersed nature of risks often is responsible for the threat of suit issue that potential plaintiffs go through as they find it very difficult to identify the actual operator(s) responsible for certain harms which is a requirement in law to establish the link between causation to impute liability on a party.

This kind of gap that traditional regulation and liability systems have not been able to address can, however, be addressed through a change in policy option. This is where this thesis makes a bold recommendation for a segregated licensing scheme for potential operators within a probable or proven shale gas reserve. As the name implies, it is a designation of licensing regime that gives each operator or group of operators a certain demarcated explored area to commence actual exploitation. Where the shale plays are vast and seem beyond one operator's financial capabilities, group of operators should be assigned to explore and extract from that area. Those assigned operators would become jointly and severally liable for the damage that result from their licensed area.

This scheme is beneficial for managing, reducing or completely avoiding the occurrence of shale gas accidents in that the regulator or the licensing authority is very much abreast of the no go areas for shale gas exploitation activities to be carried out. This ban may be due to reports revealed during the impact assessment that any shale gas activity will affect the presence of endangered species or because the area is densely populated in the event that there is a shale gas accident. For example, where there is water contamination or a frack-site-explosion, the result will eventually be over and above the socially optimal acceptable level of harm.

Also, the segregated licensing scheme can also be useful in addressing the threat of suit problem applicable to traditional regulatory and liability systems. The segregated scheme can solve the difficulty faced by plaintiffs of oil and gas accidents if policy can issue a permit to an individual operator that covers a large area such that every other subsequent licensee can get their permit tied to the main licensee. This is unique in that in the event of any accident that eventually results to harm of the plaintiff that is near that licensed shale gas area as described in the permit or work plan of the operator(s), the main applicant is held liable. Once this is implemented through policy intervention, the legal question of determining who caused the harm and the source of the harm is addressed based on circumstantial evidence as envisaged in the license or work programme as the case may. Thus, the defendant operator would be very much aware of the difficulty in escaping-liability on grounds that the plaintiff is not aware of who and what the source of the cause for action is. In addition to the segregated licensing scheme, the joint and several liability rule can be incorporated as tools to address the threat of suit problem to achieve the required safety standards by the operator.

7.4.2 Joint and Several Liability Regime Option

This is a designation of liability regime in law by which members of a group are either individually or mutually responsible to a party in whose favour a judgment has been given. This is used in civil cases whereby two or more parties are found liable for damages. The plaintiff whom judgment was given in favour is at liberty to collect the entire judgment sum from any one of the parties in the group, or from all the parties in various amounts until the judgment is paid in full.

In this form of liability, defendants in the suit can be held jointly and severally responsible even where their concurrent acts did not bring about the harm in question to the plaintiff. The harm caused by the defendants does not necessarily have to be simultaneous, rather what the law requires is that that it was a contributory link between the same events that led to the harm to the plaintiff. Thus, the segregated licensing scheme will provide a legal exception to the requirement whereby all parties' actions must have a contributory connection to justify a jointly and severally liable to the plaintiff.

For example, let us assume at this point that a plumber negligently installs a pipe meant to convey toxic chemicals to a nearby factory underground through a neighbour's farm land.

That same pipe installed for conveying the toxic chemicals was inspected by and approved by another expert plumber. When the plaintiff suffered from loss of his entire farm crops as a result of a pipe rupture, the plaintiff, according to the joint and several liability principles, may sue both the plumber that laid the pipe and the one that inspected and approved of the work and hold them jointly and severally liable for the damage caused for their failure as experts.

From the above example, both defendants in this scenario acted negligently but we cannot conclusively say that it is the action of one that may have caused the rupture for certain but a combination of the recklessness of both. True, the first plumber may have installed a sub-standard pipe or did not do something right during installing the pipe underground. However, if the second plumber had carried out the inspection of the work properly in the first place, the defect that led to the rupture may have been detected prior to the rupture that led to the loss of crops in the plaintiff's farm land. Thus, it is a case of making a legal inference to determine liability in this context.

In relation to shale gas extraction activity and the disparate nature of air and water contamination harm, could it be said that the elements that account for the invocation of the jointly and several liability rules is present? The answer is in the affirmative. However, for this rule to work and to be applicable to solve the problem of threat of suit in relation to the shortcoming in the liability and regulatory approaches for reducing shale gas risks, certain requirements must have been established.

The first is that the number of shale gas sites and their operators depending on their proximity and distance should be categorised into one group within an area. This is important as it will be easier for regulators to identify the group based on the present location of the plaintiff whose surface or groundwater sources has been impacted from suspected shale gas operations.

Secondly, each member of the group should have been engaged in such an activity that could be the probable cause of air or water pollution during the same length of time and period or regulation should have fixed the number of years for each operator to be affected by the joint and several liability rule to cover such a disparate nature of liability.

When one critically reviews the dynamic of the joint and several liability rule, it resonates an advantage in that it reduces the plaintiff's risk that one or more defendants are judgment-proof by shifting that risk onto the other defendants. The downside of this rule is that it creates inequities amongst defendants where a relatively blameless defendant is forced to bear the financial burden of a guilty co-defendant's insolvency.

7.4.3 Information Disclosure Option

The information disclosure policy rule option (extensive discussed previously in chapter VI of this thesis) can contribute in increasing the effectiveness of the liability systems as well as regulation combined. This is quite straight forward in that it will equip potential and actual victims with the information they need to find out about harms and identify the relevant parties which enables them to establish causation in litigation for determining liability. For more discussion on information disclosure, please refer to section 6.1.1.

7.5 Costs

Specifically, costs have been the major bane for plaintiffs to not even commence action against defendant operator(s) in most industrial activities that result in harms. Cost involved include: gathering intelligence or evidence; cost for instituting legal action in court ranging

from court process filing and legal representation fee; costs for filing a frivolous suit against the defendant; or for wasting the time of the court.

These costs increase with time and are not one-off payments. Therefore, the issue of cost can also be addressed. It is the recommendation of this thesis that almost all the policy intervention options discussed previously above that relates to resolving information asymmetries, addressing the judgment proof defendant problem, and issue of defendant's ability to escape liability play roles in reducing the costs involved in litigation. Information disclosure rules assist the plaintiff in acquiring information with less hassles rather than relying on expensive discovery options.

However, other measures which this thesis thinks should be explored to addressing the cost problem are discussed below

7.5.1 Shifting the Burden of Proof Rule Option

This legal and philosophical concept requires making a claim that also needs justification which then expects that the opponent justifies the opposite of the claim. Although this concept is quite different in each legal domain, one common trend applicable to all domains is that the burden of proof typically lies with the party making the claim. This can also lie with the other party denying a well-established fact or theory.

The question we need to address is whether the burden of proof should at any point in time shift to operators of shale gas sites. To answer this question, it is important to first identify the criteria that ought to be evident before a court can order a shift in the burden of proof in litigation. One of such criteria taking a cue from an employment case of, *Ayodele v. Citilink Ltd & Anor*,[693] where Lord Singh held that the Equality Act of 2010[694] does not exonerate the claimant from the burden of proof merely because words contained in the Equality Act of 2010 suggests otherwise. Instead, he said it is not fair that a respondent should have to discharge that burden of proof unless and until the claimant has shown that there is a *prima facie case of discrimination* that needs to be answered.

What then should constitute a *prima facie* case of discrimination which should provoke a shift in the burden of proof in shale gas development activity? One such controversy that constitutes a *prima facie case* that should provoke a shift in the burden of proof on a claimant to the defendant lies in the issue of non-disclosure regarding the chemical components that the oil and gas industry operators argue for. These operators claim it infringes on their property rights. The mere refusal to disclose the chemical composition being used for fracking invariably represents a discriminatory advantage against the plaintiff to be able to prove his case on the balance of probability because the defendant is well equipped in terms of information. Therefore, the burden should shift to the defendant where they refuse to voluntarily disclose certain information while carrying out their operations. This is equally in

[693]Ayodele V. Citlink Ltd & Anor (2017). EWCA Civ 1913 [Online] https://www.employmentcasesupdate.co.uk/site.aspx?i=ed36534 (Accessed on 04/07/2018).

[694]An Act of the parliament of the United Kingdom, (2010). Chapter 15. An Act to make provision to require ministers of the crown and others when making strategic decisions about the exercise of their functions to have regard to the desirability of reducing socio-economic inequalities; To reform and harmonise equality law and restate the greater part of the enactments relating to discrimination and harassment related to certain personal characteristics; To enable certain employers to be required to publish information about the differences in pay between male and female employees; to prohibit victimisation in certain circumstances; To require the exercise of certain functions to be with regard to the need to eliminate discrimination and other prohibited conduct; To enable duties to be imposed in relation to the exercise of public procurement functions; To increase equality of opportunity; To amend the law relating to rights and responsibilities in family relationships; And for connected purposes.

line with the wisdom behind the burden shifting rule because the burden of evidence gathering is on the party able to meet it at least cost.

Another condition which needs to be fulfilled before the burden can shift to the defendant operator is that the proceedings filed before the court must be *adversarial* and not *inquisitorial* in nature; that is, the courts or the competent body does not need to investigate the facts to the case itself.[695]

7.5.2 Expediting Litigation Option

Obviously for locations where there are high volumes of oil and gas activities, there are bound to be frequent accidents associated with shale oil and gas exploitation. In order to deal with the numerous litigations, there is a requisite need to appoint enough judges to manage present and future proceedings. Apart from the regular adversarial court systems, government should endeavour to establish quasi-judicial bodies to look at minor incidents whose duty it is primarily to investigate matters of claims and the duty of care on the part of a defendant operator. This is unique because the normal adversarial adjudicative processes take a long time to conclude. This will improve the ability of courts to efficiently dispense with cases and encourage more plaintiffs in pursuing claims in court. In addition, this will make operators of such industrial sites to be more careful since they know that the processes for litigation has been simplified drastically for any potential plaintiff. However, these quasi-judicial bodies, the cases that should be transferred to them should be limited to cases not involving the interpretation of legal texts to determine the fact in issue for holding a party liable.

7.6 Summary

The identified problems of environmental regulation for mitigating risks from activities especially in the energy industry and energy law principles are suggests that the implementation of operators compliance to set regulatory set rules and programmes does not equal an increase in compliance or in optimal regulatory outcome.[696] This results in companies indulging in expensive environmental and liability compliance systems in response to unnecessarily complex laws. Indeed, the proffered policy alternatives to environmental regulation for mitigating risks discussed in this Chapter resonates thematic issues of emerging research to analyse the extent to which environmental risk regulatory tools and innovation in the energy industry is compatible with regulatory effectiveness in improving compliance and achieve policy outcomes. Porter and van der Linder have suggested that environmental regulation and liability can be a veritable tool in stimulating companies to be innovative is devising self-regulatory frameworks for mitigating risks.[697]

On the whole the innovative alternative policy interventions creates an opportunity but forces regulated firms to take responsibility itself in its own ways in response to regulation. Therefore, it turns out not to be a question of whether there was compliance, but a question of whether the policy and regulatory objective is achieved in safety and risk mitigation that contributes to a healthy environment. Regulated entities are not being weighed down more

[695]See Article 4 (3) of Directive 97/80; Article 8(5) of Directive 2000/43; Article 10(5) Of Directive 2000/78 and Article 19(3) of Directive 2006/54.
[696]Schmidheiny, S. (1992). Change Course: A Global Business Perspective on Development and the Environment, MIT Press, Cambridge, Massachusetts.
[697]Porter, M & Van der Linder, C. (1995). "Green and competitive: Ending the stalemate" *Harvard Business Review,* September-October, pp.120-134.

and more by prescriptive rules offers little which hampers the company's ability to innovate.[698]

Theoretically, flexible regulatory regimes that its design is outcome driven rather than rules oriented, then compliance with risk mitigation programmes can fit well into the company's normal operating procedures, training programmes and business goals. It will be cost-efficient and competitive such that regulatory monitoring will almost be unnecessary to ensure a safer environment. However, most regulators approach and business strategies is still far from attaining ideal conditions of regulatory effectiveness posited by the theory.

Strict liability are also being seen as one of the palliatives to the problems identified in this thesis as well as by critical energy law scholars of how to ensure that liability regimes permeate the internal orderings of regulated entities, ensure that operators will be held responsible for dispersed harm which are quite difficult to attribute to a particular operator. The risk based strict liability rule for addressing water contamination issues helps to avoid the possibility operators to be shielded from liability where they have complied with prescriptive regulatory set standards. Conversely some scholars have suggested that the best way forward is to require large energy companies to regulate themselves (i.e. to implement internal outcomes-oriented compliance systems in a way that is responsive to regulatory concerns.[699]

The objective is here is to focus regulatory efforts in the direction of those able to shoulder the costs of environmental remediation and force major industry players to act as surrogate regulators. As a result, these surrogate regulators provide the economies of scale for smaller players to comply with the standards towards risk mitigation. Thus, there is an increased level of efficiency in environmental regulation and liability regimes.[700] Consequently, regulatory efforts anchored on risk based strict liability does not limit itself to the potential degree of harm from an activity in defining what an abnormal risk is. Rather it takes into consideration the probability (increased frequency level of risk occurring) of particular risk associated with an activity. (See thesis body on *factors (a) & (b) Great harm and higher degree of risk,* section 5.8.1).

Also, the era whereby energy corporations as subjects of regulation are pictured as institutions who have to be forced to 'do the right thing' through deterrence threats must be backed up by the facts that corporations can 'do the right thing' through persuasive regulatory approach. Some influential regulated firms will be highly responsive and motivated to act in rational ways for its own sake, that the presence of deterrence threats will not necessarily make firms to make it a feature of a daily decision to be receptive to safety rules that mitigates risks from energy related activities. Many regulated firms will also act in ways that appears to preserve their corporate legitimacy and reputation in the eyes of their peers, clients or government irrespective of what it will cost them. In circumstances where formal punitive measures are asserted, it is the use of informal approach such as shame and negative publicity that turns out to be more effective motivators for compliance with risk and safety regulatory requirements.

[698]Boyd, J. (1998). Searching for the Profit in Pollution Prevention: Case Studies in the Corporate Evaluation of Environmental Opportunities, Discussion Paper 98-30. Resources for the future, Washington DC.
[699]Selznick, P. (1992). The Moral Commonwealth, University of California Press, Berkeley; Mclnerney, F. & White, S. (1995). The Total Quality Corporation: How 10 Major Companies Added to Profits and Cleaned up the Environment in the 1990s, Truman Telley Books/plume, New York.
[700]Caltkins, S. (1997). "Corporate compliance and anti-trust agencies' bi-modal penalties" *Law & Contemporary Problems* Volume 60(3), pp. 127-167.

No doubt regulated firms will frequently be responsive to weak sanctions including publicity and shame because there are usually variety of actors associated with any wrongdoings.[701] However, this thesis argue that when there is an increased frequency level of risk from an activity, it therefore portends that weak sanctions can no longer achieve its corrective aim. In such cases, a strong deterrence threat such as a risk based strict liability regulatory approach becomes relevant. To hard targets, maximum penalties will not deter them. To those vulnerable regulatory targets, maximum penalties will be relevant in deterring them. Whereas, weak sanctions (shame or publicity) will deter soft targets of regulation, by the mere exposure of their inability to meet their legal obligation even if does not provoke criminal responsibility.[702] Interestingly, the energy industry is such that is comprised of a mix of both hard target and vulnerable target firms that requires a blend of maximum and minimum punitive measures to achieve an effective regulation in mitigating risks where necessary and depending on the nature of firm.

[701]Fisse, B. & Braithwaite, J. (1993). The Impact of Publicity on Corporate Offenders, State University of New York Press, Albany.

[702]Fisse, B. & Braithwaite, J. (1993). Corporate Crime and Accountability, Cambridge University Press, Cambridge

Chapter 8

8 Final Conclusions and Future Outlook

8.1 Introduction

The question of whether a stricter liability and an alternative regulatory regime are required to complement the existing regulatory regime that govern shale gas extraction activity is the main trigger for this research. Both arguments for and against this question has been examined in this work. The limitations of a one size fit all model of regulation from the perspective of this thesis is been criticized. First on the premise that liability based on negligence can create an incentive for operators who engage in activity that produce increased frequency level of risk to be shielded from liability. Why this happens is because the claimant in most cases is unable to prove the negligence of the defendant operator as the evidence might have been destroyed in the accident or incident. The oil and gas extractive industry is where such difficulties might be present and creates for the threat to suit syndrome in environmental litigation cases. Second, C&C regulation presents a legal gap in that operators might be shielded from liability having satisfied all prescriptive standard of regulation for carrying out the activity or operation that results in the harm to the victims of environmental pollution or accident. These issues will be summarized here and the position of the thesis shall be presented as it attempts to answer the questions raised in this work.

This thesis, to set the basis for the conclusion and its future research outlook, demonstrated through legal based principles and concepts as to why shale gas extraction activity should be subject to stricter environmental liability regime by stating that because the issue of water contamination risk has an increased frequency level of incidents on one hand. Again, this research argued that when these contaminations occur the water resources are irredeemable.[703] Thus, the thesis views such risk as abnormally dangerous based on a legal concept formulated by this work known as the 'transgenerational impact factor.' It relied on the factors contained in the Restatement (Second) of Torts Act to argue its position to subject shale gas fracking water contamination risk to a strict liability and regulatory regime based on the transgenerational impact factor. Also, it proposed self-regulatory approach as a complement to command and control environmental regulation.

Now to answer the main research question whether shale gas activity should be subject to a strict liability and regulatory regime. This work agrees strongly that water contamination risk should be subject to a strict liability cause of action when claims for water contamination arise. But strongly disagrees that shale gas activity in its entirety should be subject to a strict liability and regulatory regime as long as there are no increased frequency of any of the risks associated. In order for this proposal to fit to the existing environmental laws, legal principles and regulation, this thesis formulated a new concept of liability known as the 'risk based strict liability rule.' This thesis illustrated that this rule can be triggered based on two conditions: whether the frequency level of that risk occurring is highly probable or when it does occur whether the resultant harm can have a transgenerational effect on the victim.

However, the down side of the risk based strict liability rule is that it can only be triggered and applied when the activity that might present such risks has actually commenced. Before this thesis concludes, it is important to draw a nexus between the principles of sustainable use of natural resource and the obligation to imposed by national and international statute for the

[703]See supra Weiss, E. B. (1989) footnote 437.

need to protect the environment and why the this thesis contributions fits with energy law scholarship.

Environmental consequences are bound to follow every energy exploration and extraction through processing and transportation and then to distribution, consumption, and disposal of the natural resources that are deployed to produce energy. From the above, it leaves an unassailable conclusion that energy and the environment share a much more physical connection in the fuel cycle. As a result, it resonates the impossibility of the idea whereby energy law and policy and environmental law and policy can be treated as different areas of regulation. Remarkably, the phenomenon of irreversible damage associated with energy activities exacerbates the environmental problems attendant with energy system. For instance, the energy industry being the main contributor of CO_2 emissions which is an irreversible phenomenon that leads to climate change that imposes risks and fatalities on humans.

Undoubtedly, there are trade-offs that ought to be addressed or more importantly overcome between energy and the environment.[704] These trade-offs are necessary because historically traditional energy narrative focused on economic growth where all sophisticated economy focus more on cheap, readily available and reliable energy sources. Inevitably, the need for energy and national security as well as environmental protection to be included in the drive for accessible energy sources has become the core input for contemporary energy policy.[705] The environment, human health, energy security and the economy are all impacted by all forms of energy extraction activity. The key always is to examine each energy source for its full life cycle impacts with a view to proffer the strategies which will engender effective compliance to mitigate the attendant risks. Nevertheless, one thing stands out in comparison to other human activities, the extractive sector present clearer, more numerous, more severe, and irreversible risks.

Therefore, to strengthen the principles of sustainable use of natural resource and the need to protect the environment which overall constitute the bases for energy justice within energy law and policy objectives, there must be a framework strategy that promotes the parameters of self-regulatory and stricter liability policy interventions which in turn ensures an effective compliance with set rules for risk mitigation. The link is this, self-regulatory and stricter liability systems erodes the notion whereby regulators relying on their ability to implement *ex post* regulations that address and fix a problem, such as oil spill or water contamination or even a nuclear malfunction that has occurred in the past. Instead, forward thinking industry formulated *ex ante* measures are necessary in an effort to forestall continuing and increased frequency levels of risks from energy extractive activities.

8.2 Research Contributions

One important issue faced by modern societies is how to avoid severe, presumably cataclysmic, harm to the natural environment. The reasons behind such harm are not only complex but controversial, and they arise from a wide spectrum of economic and social pressures. The results are evidenced in the apparent pollution, land degradation, deforestation, ozone depletion, climate change, and the loss of biological diversity which creates severe and, in some cases, transgenerational impacts to the planet that is required to sustain us. Consequently, it has been argued that the window of opportunity in which to avert these

[704]See Heffron J. R *et al.,* (2018) supra footnote 18 at p.44
[705]Tomain, JP. (2011). Ending Dirty Energy Policy: Prelude to Climate Change (CUP 2011) chs 3 and 4.

ecological disasters is rapidly closing in, and that in some cases, it may already be too late to prevent ongoing health implications and environmental degradation.[706]

One solution to manage these severe risks associated with resource extraction which accounts for related impacts on the natural environment and humanity has been the use of regulation and liability regimes.[707] However, in today's world, all indices points to the fact that recent technological advancements have presented a situation where direct (C&C) regulation can no longer adapt to the changing dynamic of technology in several fields of discipline. One area where this miscarriage is so evident is in the extractive industry. Regulation is said to have been operating from a distance rather than taking the centre stage in mitigating the attendant risks. More pathetic is the fact that companies, and not regulators, decide on the details on safety governance, production technology, and quality of product.

The issue of information asymmetry has been the fundamental reason behind this twist in the safety governance issues and quality of production technology in the energy industry. This invariably leads to the limited effectiveness seen presently in today's regulatory environment surrounding shale gas extractive activity. Given the room to re-regulate, how can we attempt to further strengthen the effectiveness of regulation without forfeiting the benefits resource extraction activity offers? Put another way, how can we re-regulate to balance the conflicting needs between what is beneficial to society and what is beyond the socially optimal level of harm to the same society? These underscores the significance of this research.

To deal with these questions, it is the assumption of this thesis that regulation can be more effective and improved upon if it does not neglect the strategic regulatory approaches which will force the industry to self-regulate. This is important because indirect control otherwise known as self-regulation is compatible with controlling dispersed harms associated with highly risky activities like shale gas extraction. It is also ideal in that it reduces the uncertainty in immature technologies as well as addressing the asymmetric information syndrome prevalent in resource extractive technologies. These problems provoke a strong incentive for regulatory subversion or capture by the operator.[708] Thus, breeding a fertile ground for non-compliant participants to the set regulatory rules targeted toward mitigating risks in the energy sector.

Therefore, the implication of this thesis is explicitly to devise a legal complementary framework where environmental liability and regulatory strategies would be able to engender higher levels of compliance as well as achieve policy and regulatory objectives from the context of energy law principles that govern operations of resource extraction. The thesis seek to not only improve compliance with regulatory standards or requirements. It went further to argue that achieving compliance alone cannot be the true determinant of an effective regulatory strategy. To this end, this thesis have also taken a step further to contribute to the available literaures by proposing specific strategies that will foster rational behaviour amongst regulated entities in the energy sector. Thus, this thesis contributed to the available literature by not only agreeing that a combination of multiple regulatory instruments should be used to improve regulatory quality. Rather it clearly argue for a self-regulatory approach to be combined with traditional regulation to achieve effectiveness in regulatory strategy.

The interrelationship between self-regulation, C&C regulation and risk is analysed explicitly in section 1.8 and 2.3.1 respectively. Also, for a better understanding of how self-regulatory strategies yielded the desired level of compliance, section 4.5.3 and 4.6 identified examples

[706]See supra Selcuk, B & Ikbal, S. (2016) footnote 39.
[707]See supra Aven, T & Ylonen, M. (2014) foot note 40 at pp.164-171.
[708]See supra Aven, T & Ylonen, M. (2014) foot note 40 at p176.

of how self-regulatory strategies have been a success in ensuring compliance and mitigating risk safety compliance problems. From the examples, examined in the above sections, it is the assertion of this thesis that self-regulation, not prescriptive (context based) regulatory standards should be the core trigger for human rationality. The human brain developed as a sophisticated social brain to be to deal and adapt to self-regulatory responses in most contexts and overrule, if need be direct external context based regulatory responses.

Consequently, when human rationality is viewed as having evolved together with the problems of risks mitigation for adaptive behaviour in a changing environment like the energy sector, it invariably results in a social kind of rationality that is connected to self-regulatory and internal management strategies adaptable to the complex social interdependencies of collective efforts.

Aside the examples cited above in section 4.5.3 and 4.6 it is imperative just to consider yet another success that proves further the effectiveness of self-regulatory strategies in improving compliance. Here the EPA was facing problems in the way it communicated with local communities in the regulation of companies' proposals for development and other issues. Significant conflicts between local communities and facilities on environmental issues were amongst other problems being faced by the EPA, with many local communities not pleased with the level of environmental improvement achieved by the EPA, working with local facilities. In Altona an area in the U.S, where two catastrophic accidents had occurred over a ten year period. As a result, the residents were generally opposed to every application brought by local facilities for developments or changes. Due to these oppositions from local residents, it affected the EPA's attempts to work with these facilities to achieve its objectives of pollution prevention and control.[709]

To deal with this deadlock, the EPA set in motion a compliance plan where a community liaison officer was appointed to facilitate consultation between management and local communities to address these challenges as well as set objectives for environmental improvement in local facilities. The consultative group set up for each of the plant is comprised of local community representatives, those who had complained to the EPA about the plant and top management of the plant. The consultative groups met monthly to understand, identify and understand the environmental issues confronting the plants, from the plants' and communities' perspective and to agree on an improvement plan to address those issues. The EPA acted as a neutral party to provide advice in and to facilitate such consultative meetings. When the groups have devised a working expected initial plan, they now meet quarterly to hear reports of the implementation of the plan and to tackle new issues. This process is repeated every two years.[710]

The Accredited Licensee concept is set up by the EPA as a reward for companies with good environmental performance. An "Expected Initial Plan" (EIP) is one of the key indicators of this performance level. Sequel to an amendment made in Victoria, a state in Australia to the Environment Protection Act 1970, gave companies some leverage to be freed from the standard prescriptive approach to works approval and licensing if they can demonstrate a higher level of environmental performance as well as an ongoing ability to maintain and improve performance. However, to be an accredited licensee, a company must have: an

[709]Environmental Protection Authority (1993). "A question of trust: Accredited Licensee Concept." Discussion Paper, Environment Protection Authority, Melbourne, Victoria

[710]Law Reform Committee. (1997). "Regulatory efficiency legislation: Discussion Paper", Parliament of Victoria, Melbourne, Paragraphs2.23-2.28; Author's research at the EPA

environmental management system, an environmental audit programme and an environmental improvement plan.[711]

This accredited license concept yielded a gradual success such that as of 1998, there were 32 EIPs agreed by the local consultative groups already in effect and further 18 in the process of consultation and agreement. Again, a total of 11 accredited licences had been issued out of a total of 1229 licenses issued in three years. The EIPs have resulted in huge improvements in environmental outcomes for particular sites such as a halving in emissions of volatile organic compounds at Alton between 1989 and 1998.[712]

From the above example, it is evident that another way regulation can become effective in engendering an increased level of voluntary compliance for mitigating risks associated with dangerous activities, is to provide companies or individuals with a reduction of penalty if they are found to have breached the set regulatory standards. The U.S Federal Sentencing Guidelines for organizations is the most significant development of this kind of legal leverage. This guidelines that gives reduction in penalty were promulgated by the U.S Sentencing Commission, a judicial agency which went into effect without congressional action. How this operates is that companies who have initiated good compliance programme's design by certain elements in the Guidelines will enjoy decreased fines when they commit an offence. On the other hand, companies who lack such defined compliance programmes are placed on probation pending when they are willing to initiate one. Many regulators have copied this scheme where companies' programmes reflect that of the U.S Sentencing Commission Guidelines. In fact, this scheme from surveys has shown that the guidelines caused up to 20% of the companies under review to initiate for the first time an internal system for ensuring regulatory compliance and up to 45% to further improve their internal compliance system.[713]

Accordingly, it is the conclusion of this thesis that strategies targeted at improving regulation cannot be effective in encouraging compliance toward mitigating risks from activities if regulated entities lack the expertise or capabilities on how to comply with set regulatory standards and requirements. The responsiveness of enterprises to deterrent threats of punitive sanctions or economic incentives such as workers compensation as the case may be, depends on the information or technological capacity to comply. No matter how decent and strong a regulatory rule may seem, firms will not seem to comply except that regulation addresses the problem of capacity building. Thus, if regulation ought to be effectiveness in risk mitigation in the energy industry, it is expedient for regulators to nurture and improve regulated firm's capacity to comply with these set standards by providing a level playing field for all participants. This is essential because smaller firm's lack the economies of scale to invest in systems that engenders a traction for compliance. This also account for the irrational behaviour of some operators within the energy industry.

Given these advantages, how can environmental regulation overcome the shortcomings inherent in self-regulatory approach in mitigating risks associated with resource extractive technique like fracking? Unlike other scholars[714] that have proposed or argued vaguely that regulators could better manage the risks to water contamination from fracking activities by strengthening regulatory safeguards, incentivising research, clarifying tort responsibility and using insurance mandates to ensure compensation and remediation.[715] This thesis proposes

[711]Ibid
[712]See supra Saul, L. (2008) footnote 691
[713]Genn, H. (1993). "Business responses to the regulation of health and safety in England" *Law & Policy* Volume 15, pp.219-233.
[714]See supra Ayres, I. & Braithwaite, J. (1996) footnote 120 at p.334.
[715]Ibid.

self-regulatory approaches through specific strategies to overcome the shortcomings of direct regulatory approaches suggested to mitigate the risks of dispersed harms.

Again, considering the widespread ban on fracking technology within States in the U.S[716] and within the EU due to its environmental impacts, this thesis aims to develop a framework that will give members of the public the assurance that there are enough safeguards that guarantees keeping risk mitigation to a socially optimal level. Also, it precludes the operator of a dangerous activity to be shielded from liability because he adhered to the prescribed best practices or regulatory requirements. On the reverse side, operators of energy related activities will be given the social license to operate as members of the public are quite confident that justice would be done if harm occurs.

Prior efforts to mitigate certain risks associated with extractive activities through regulation and liability fell short in capturing the effectiveness required for achieving a socially optimal level of harm. For example, Shavell Steven in his work [717] clearly outlined the issues that confronted the tasks of mitigating risks. Such issues include: information asymmetry; inability of a judgment debtor to pay; the cost involved in suing an alleged defaulter; and threat to suit. He vehemently argued that the issues of energy are fundamentally entrenched in an indissoluble nexus with multiple dimensions that, in turn, exert asymmetric influence over divergent stakeholders and settings and occur at different spectrums and physical scales. Having done that, Shavell did not take a definite stance on the issue of the best tool between liability and regulation in mitigating risks associated with resource extraction.

Rather he proposed a combination of both by highlighting the merits and demerits in both tools. Also, Caroline Cecot in her article '*Fractured Systems: Multi Policy Proposal for Promoting Safe Shale Gas Delivery in the United State'*[718] clearly toed the line of argument coincidentally by proposing multi policy strategies. The work identified the use of liability, regulation and financial liability schemes such as the establishment of "Superfunds", which obligates operators to contribute to the fund. Here she suggested operators with the greatest default should be made to contribute more. However, their work did not contain specific strategic policy options that might address the issues of dispersed harms that are associated with shale gas fracking. Further, they[719] did not clearly recommend a system that would strengthen the effectiveness of regulation by ensuring compliance without the regulatory institution closely monitoring the operators of such risky activity. It is based on these overarching premises that this thesis builds upon to provide specific policy options that might help to address the asymmetric influence over diverse stakeholders as prevalent in the industry. Furthermore, this thesis seeks to add to the collection of solutions Shavell proposed for each of the problems that confronts regulation and liability systems. Thus, the thesis' contribution to the available literature regarding safe shale gas extraction has the following ramifications discussed below.

This research argues for a combination of policy proposals for strengthening the existing regulatory system. Specifically, the work proposed and agreed with some of the suggestions of scholars that for there to be safety in energy related extractive activities like shale gas fracking, regulators need to clarify tort responsibility. This is true. However, this thesis seems to be quite bold in arguing for a strict liability to be applied to fracking risks to the extent that it involves water contamination claims by adducing evidence that suggest that this is the most

[716]See supra Loftis, R. (2013) footnote 44 at p.23
[717]See supra Bechara, A & Damasio, A.R. (2005) footnote 58.
[718]See supra Wendy, W. (2015) footnote 77.
[719]See supra Shavell, S. (1984) foot note 288.

prominent risk *(See section 3.5).* The legal rationale for this is anchored on the argument that water contamination risks are the most to occur in terms of frequency presently in the U.S. Also, on the premise that water is a special commodity which ought to be protected in line with the objective of the United Nation (UN) Millennium Development Goals.[720]

More so, energy development is the most rapid growing consumer of water in the US and around the world.[721] And any attempt to prioritise gas as an energy source over water means that the very essence of living would disintegrate as the status of water and energy are distinct and contribute immensely to the aspects of the UN Sustainable Development Goals (SDGs). Therefore, if strict liability is applied to water contamination claims, it would make operators to conduct impact assessments and rigorous testing of techniques instead being in a haste to introduce technologies with great impacts.

Furthermore, this thesis makes a novel contribution on how to solve the issue of liability claims when it comes to dispersed harms from oil and gas extractive activities like shale gas. Dispersed harms from extractive activities makes a potential plaintiff unable to sue a defendant-operator(s). This indirectly gives the operator the incentive to continue the polluting act. Some of such dispersed risks could be air and groundwater contamination. This thesis contributes by specifically identifying the independent segregated licensing scheme to address this difficulty faced by potential plaintiffs. By this, the thesis sets out that when issuing licenses for exploration and extraction of energy sources, the relevant licensing authority should designate a large area to an individual licensee where by other license holders can trace their rights to the original license holder. In the event of a dispersed air or groundwater contamination where the source is unknown, it affords the plaintiff to sue for liability claims connecting that harm to the original license holder. This resonates the joint and several liability rule under tort law and thus clearing any ambiguity surrounding the perpetuator of the alleged harm and addressing the 'threat to suit' problem inherent in direct forms of regulation.

This thesis made another contribution in addressing the information asymmetry syndrome and the inability to pay/judgment proof defendant problem which accounts for the regulatory subversion or capture and the shortcoming of liability systems in mitigating risks by suggesting self-regulatory policy interventions. To address the information asymmetry each well should have an 'independent well assessor' whose responsibility is to report directly to the regulatory institution. Whereas, a model known as the 'Polluter Does Not Pay' is proposed to tackle the inability to pay/judgement proof defendant. How this works is that the plaintiff who is unable to recover in damages against the defendant because the defendant's available assets cannot cover the judgement sum, the plaintiff can recover same from the government who in the first place gave the judgement debtor the license to engage in the activity that caused the said harm. However, this model will only work for most legal systems where the ownership of mineral rights resides with the government. The government in turn may recover same from the mother-company or benefit from the insurance or bonding cover in place. It also allows for expediting payments for damages to do victims of environmental accidents.

8.3 Final Conclusions and Future Outlook

In the context of resource extraction activities, restructuring can be provoked when the existing legal framework shows limitations in meeting the interests of all parties' that are going to be either affected or benefit from an activity. Such interests on the part of people living around that activity is the issue of their safety and where damage occur, adequate and

[720]See supra Loftis, R. (2013) foot note 44 at pp.34-44
[721]See supra In: The Elgar Encyclopaedia of Comparative Law (Glenn 2006) foot note 54

fair compensation. The interests on the part of the operator of such activity is to recover returns on—the investment. The satisfaction of these divergent and conflicting interests is solely on the regulatory institution and liability regime whose responsibility is to ensure a balanced arrangement between the various stakeholders in resource extraction activity in the energy industry.

The development of shale gas resource through the combination of innovative techniques known as the directional drilling and high volume fluid based fracking technique could become beneficial globally if harnessed sustainably. This is because more energy resources will be available to meet the demands of energy needs of the world. However, these new technologies has equally presented new risks that show that the existing environmental regulatory laws in some legal jurisdictions have become obsolete and too weak to improve compliance level for set safety standards. One way in mitigating these risks associated with resource extraction activity like shale gas is through the use of environmental regulations and liability systems. However, there has been series of debate in the global energy forums regarding environmental regulatory reforms. Whether stricter or lighter forms of regulatory and liability regimes is ideal to achieve an effective means of mitigating risks. This has in fact, taken the centre stage of discussion in environmental forums. These conflicting perceptions provokes the main research question: whether shale gas extraction activity should be subject to a strict environmental liability and regulatory regime to achieve a sustainable shale gas development?

To answer the question, this thesis reviewed and analysed the U.S regulatory and liability regimes applicable to shale gas extractive activity. This is to determine its ability in achieving the environmental health protection. This research reveals that there is a wide array of legislations at both state and federal level that govern the operations of shale gas development. However, these traditional regulations alone are limited in achieving a higher degree of compliance and policy outcomes.

On the other hand, the thesis examined shale gas health and environmental impacts. Now based on the available literature that analysed the risks of shale gas, this thesis observed that water contamination seem to be the risk with an increased frequency rate of occurrence. To substantiate this assertion that water contamination risk is one of the fundamental issue, it is pertinent to mention that the GWPC in the U.S published a review of state oil and gas regulations designed to protect water resources for twenty seven major oil and gas producing states in 2009.[722] On the backdrop of this review, GWPC concluded that, in general, state oil and gas regulations are adequately designed to protect water resources. Among the states reviewed, requirements to protect water resources covered permitting, well drilling and construction (Eg. casing, cementing, and pressure test requirements), well closure and abandonment, and waste fluid management.[723]

While the review shows that there were regulations intended for protecting water resources, it mentioned that few states explicitly mentioned hydraulic fracturing in their regulations and found that most states had an extensive array of permitting and operating requirements for oil and gas wells. As a result, the review made a list of findings and recommendations to strengthen state programmes to protect water resources. In similar light, the recommendations made by the Secretary of Energy Advisory Board as instructed by President Obama on March 31 2011 reveals the following recommendations to address the safety and environmental

[722]See supra Chenok, D. (1997) foot note 358 at p.59.
[723]Ibid.

performance of shale gas production.[724] They include: Possible pollution of drinking water from methane and chemicals used in fracturing fluids; air pollution; community disruption during shale gas production; and cumulative adverse impacts that characterise shale gas production can have on communities and ecosystems. Among the concerns identified by the subcommittee, contamination of drinking water is first on the list signifying once again the major high risk level for water contamination.[725]

Based on empirical data, this thesis have shown that water contamination risk is unique to fracking by first analysing four scenarios for which this single risk can occur as shown in Chapter III in section 3.5. Second, by perusing through articles conducted on shale gas incidents analysis. These articles revealed that among all the incidents and accidents from shale gas fracking, water contamination happen to be the most frequently occurring risk. At this point a quick statistical analysis of the number of violations that occurred from January 2008- June 2010 in the U.S during shale gas development is necessary to show the frequency in which water contamination occur. The Pennsylvania Land Trust Association has reviewed environmental violations accrued by Marcellus Shale drillers working in Pennsylvania. At least, a total of 1,435 violations of state oil and gas laws due to gas drilling or other earth disturbance activities related to natural gas extraction from the Marcellus Shale in this two-and-a-half-year period. The association identified 952 violations as having or likely to have an impact on the environment. 483 were identified as likely being an administrative or safety violations. The report breaks the violations down by type. For example, of the 952 violations: 268 involved improper construction of waste water impoundments, 10 involved improper well casing, 154 involved discharge of industrial waste and 16 involved improper blowout prevention.[726] From the report, it clearly shows that violations relating to water protection issues is more.

This can only further embolden the justification for imposing a maximum or stricter environmental regulatory approach for mitigating increased level of risks from activities has gained credence in energy law principle in achieving compliance and policy objectives. This most authoritative theory of the optimal mix of regulatory strategies in mitigating such increased frequency level of risks from an activity is Ayres and Braithwaite. In their 1992 book, '*Responsive Regulation'* on the pyramid of enforcement strategies, they gave reasons why this pyramid of regulatory strategies is an effective and efficient approach in persuading compliance with policy objectives on the backdrop of empirical psychological and sociological evidence, as well as economic and political modelling and game theory.[727] The pyramid suggest the idea that regulators should leverage on the goodwill of those they are regulating, by persuading them to voluntarily comply. When this approach fails, regulators should then resort to using their most drastic regulatory strategies and reverting to a trusting demeanour when these strategies achieve its goals.[728] From their argument, it suffice to say that compliance is optimized by regulation that is contingently co-operative, tough and forgiving. Thus, regulatory design should prioritize restorative, compliance-oriented means

[724]Stephen, G. *et al.,* (2011). Methane contamination of drinking water accompanying gas well drilling and hydraulic fracturing, Institute of Ecosystem Studies, Volume 20, pp.8172-8176 [Online] https://doi.org/10.1073/pnas.1100682108 (Available 12/10/2018).
[725]Ibid.
[726]Indiana University of Pennsylvania, 'Marcellus Shale Drillers in Pennsylvania Amass 1,435 violations' at http://www.iup.edu/newsitem.aspx?id=97300&amp (Accessed on 06/08/2017).
[727]Ayres, I. & Braithwaite, J. (1992). Responsive Regulation: Transcending the Deregulation Debate, Oxford University Press, New York.
[728]Ibid at p.51

without compromising the possibility of using stricter measures where necessary.[729] And where necessary from the context of risk governance can be construed as when risks from an activity (water contamination from shale gas fracking) has this increased frequency level of occurrence.

The ideologies and theoretical principles of Ayres and Braithwaite apply to regulatory schemes for the whole industries and not limited to individual regulatory encounters. Therefore, the concept postulates that allowing an industry the discretion and responsibility to implement sel-regulatory reform strategies first rather than moving straight to imposed C&C regulation, gives the government the leverage to be more successful in achieving their goals of regulatory reforms. On the aspect of using self-regulation to complement C&C regulation, this thesis demonstrated that C&C otherwise known as prescriptive environmental regulation have certain difficulties that accounts for its limitation in mitigating risks. First, prescriptive regulation offers no incentive to improve the quality of the environment beyond standards set by a particular law. Once the C&C regulation is satisfied, polluters have zero incentive to do better. Second, C&C regulation is inflexible. It usually requires the same standard for all polluters or those within the same line of activity. Often the same pollution abatement and risk mitigating technique is used across board. This means that C&C regulation draws no distinction between risks that are abnormal or between firms that would find it easy and inexpensive to meet the pollution standard-or to reduce pollution even further-and firms that might find it difficult and costly to meet standards. As a result, firms have no reason to rethink their production methods in fundamental ways that might reduce risk even more and at lower cost.

Third, C&C regulations are written by legislators and the Environmental Agency. Therefore, they could be subject to compromises in the political process. Every firm argue-and lobby that stricter environmental laws are full of fine print, loopholes and exceptions. Based on the incessant lobbying by these oil and gas firms, these political elites can influence the environmental policies to favour the firms as compensation for financing their re-election whilst campaigning for political offices. Based on these difficulties inherent in C&C regulation that this work subscribes to a stricter environmental liability and regulatory approach for mitigating certain classes of risks.

The risk/segment based strict liability rule is formulated in this research because of the nature of shale gas extraction, the fact that the technique of slickwater hydraulic fracking is relatively new and as such the industry is still guising some aspects. Also, there is the issue of information asymmetry between the defendant operator and the claimant where fracking claims come up. This phenomenon makes it difficult for the claimant to prove the negligence of the defendant in civil suits to recover in damages. Reason being that most often than not; the evidence is destroyed in the accidents or incidents that led to the claimant's harm. Thus, from an equitable stand point the claimant in such position has a lot to grapple with in proving the guilt of the defendant. Based on this, it is imperative that the burden of prove ought to shift to the defendant-operator in such scenario where evidence might be destroyed in the accidents and incidents which created the cause of action in liability suits.

To justify the need for a risk based strict liability rule, this thesis further identified and examined certain available environmental principles including '*nuisance, trespass law, and the res ipsa loquitur'* by distilling their advantages and disadvantages from a legal stand point. It also argued vehemently in accordance to the factors enumerated in the Restatement

[729]Braithwaite, J. (1999). "Restorative Justice: Assessing optimistic and pessimistic account" *Crime and Justice: A Review of Research*, Tonry M. (ed) pp.241-364.

(Second) of Torts of 1979 against the backdrop of energy extractive activities and the risks they present in order to see if it is really abnormally dangerous to operate under the present circumstance. (See section 5.8-5.8.5 in Chapter V) This thesis has argued that even if fracking is carried out with the utmost care possible, it does not eliminate the occurrence of water contamination.[730]

Although, this thesis acknowledged that both conventional and unconventional oil and gas extraction techniques can lead to water contamination. However, it dissented on the ground that water contamination incidents associated with hydraulic fracking technique is abnormal because of its increased frequency level of occurrence. Corroborating this assertion based on the high degree of risk factor (b) as contained in the Restatement (Second) of Torts. More so, the depths at which fracking take place in some shale plays are remarkably shallower when compared to conventional extraction depths.[731] Casings and cement works might fail in the process of extraction, which may be unknown by operators and residents living around shale sites. This failure in casing and poor cement works is just one channel through which water contamination can occur. Other sources include spillage from ponds at shale sites due to run of water and migration of fracking fluids underground.[732]

Therefore, it is the conclusion of this thesis that fracking is not an abnormally dangerous activity in its entirety. However, the high risk of water contamination disqualifies the notion that fracking is safe and environmentally friendly. To this end, this thesis has provided a valid argument to prove that the risk of freshwater and ground water contaminations which fracking cause should be subject to a risk based strict liability standard.

This recommendation for a risk based strict liability rule is key especially as the industry and regulatory institutions continue to suggest solutions to improve the energy policy options sustainable development and reduce risks levels from energy extractive activities. Strict liability becomes imperative to avoid increased clashes from increased fracking, thereby creating a strong incentive for fracking to continue by resolving the conflicts over whether the benefits of fracking outweigh the disadvantages. Consequently, future contamination will be limited.

On the basis of the factors in the Restatement (Second) of Torts shows that contamination threats associated with fracking techniques provokes two necessary elements.[733] First, whether an activity must necessarily involve a risk of serious harm to the person, land, or chattels of others that cannot be eliminated by the exercise of the utmost care. Second, whether such an activity must not be a matter of common usage. Thus, this work has demonstrated that the frequency at which these water contaminations take place, makes it a serious risk because water is a unique commodity that cannot be short-changed for the temporary benefits fracking presents. Accordingly, the technique of fracking is not yet a matter of common usage as it is only being used in few countries like USA, Canada while others like the UK, Poland and the rest are still making plans.[734] Common usage cannot be interpreted only in line with 'the nature of activity' but it also includes the number of locations/countries that adopt such a technique to qualify it as being used by the 'great mass of mankind.

More so, the cost implication involved in redeeming freshwater contamination is so enormous that it would be better that the contamination had not happened in the first place. In fact, it

[730]Restatement of Torts § 520(B).
[731]See supra Gray, W.B & Shimshack, P. (2011) foot note 118.
[732]See supra Vengosh, A. *et al.,* (2014) foot note 476.
[733]*See* Restatement of Torts § 520.
[734]See supra Kolb, R.W (2014) foot note 290.

has been analysed[735] that the cost of remediation is equivalent to the cost of adopting other best alternatives with huge cost to operate within the industry. From that, this thesis has also demonstrated that the phrase 'cost effective measures' often used whilst the acquisition of the benefits of natural resources is involved, is the root cause of the industry coming up with abnormally dangerous techniques amidst better alternatives. Where this is the case, health and environmental needs are thereby compromised in the long run.

Hence, fracking accidents that cause water contamination should be held as unavoidable risk as a matter of law. Although, fracking has been a common occurrence in the extraction of oil and gas deposits even in conventional wells, slick water hydraulic fracking does not qualify under the common usage test under the Restatement Second of Torts[736] in that, this technique is yet to be understood by the great mass of mankind. Again, examining the cases, an activity that cause water contamination harm very frequently is an abnormally dangerous one. This suggests therefore that due care cannot eliminate such an activity's potential for causing harm. It would be equitable if an enterprise is held strictly liable on the basis of the risk based strict liability model proposed by this research.

This thesis shows its relevance and contribution to the field of knowledge by formulating three additional factors to the already existing six factors enumerated in the Restatement (Second) of Torts to ascertain whether an activity is abnormally dangerous. These additional factors include: whether an activity's harm causes a transgenerational impact, the frequency of occurrence of accidents that leads to harm and whether there are better alternative techniques before operators chose the one in question. Weighing these additional factors to fracking's water contamination risks, it is evident that it clearly falls through on the abnormal dangerous activity's test. The fresh water contamination risk has a transgenerational impact because once water is contaminated, it is difficult to reclaim and it is therefore typically abandoned.[737] Even where it is redeemed, the negative perception of the contamination still lingers to the next generation.

Based on the above analyses, the first sub question of this research which seek to understand when is the appropriate time for applying a liability or regulatory tools for mitigating risks has been answered too. At this juncture it is pertinent to answer the second sub-question of this thesis. This question relates to the need to explore other features that should be included in both the risks based strict liability and self-regulatory systems as environmental tools for improving effectiveness of environmental regulation. These features are important because the public deserves assurance that the full economic, environmental and energy security of shale gas extraction will be realised without sacrificing public health, environmental protection and safety. Nevertheless, accidents as well as incidents have happened with shale gas extraction, and uncertainties about impacts needs to be quantified and clarified. Therefore, this research has highlighted innovative policy features as extensively discussed in Chapter 7 building on Shavell's proposals for improving the difficulties and limitations in regulation and liability systems that govern shale gas development. If these options are implemented, it will give the public reason to believe that shale gas resources are being developed in a manner that is most beneficial to the nation.

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[735]Amba, O. (2017). A chemical engineer under the department of petroleum Regulation in the Nigerian Regulatory Institution with 12 year experience in oil and gas extraction technique.
[736]Restatement (Second) of Torts Act 1979 factor (e).
[737]Industry Experts say fracking in the UK reveals that almost all shale gas reserves are located below major water aquifers and concludes that due to this it is almost practically impossible to drill for these resources without contaminating water. (Illustrating the comments of Dr. John Bloomerfield of the British Geological Survey, 2014).

In addition to the problems that confronts both liability and regulation as environmental protectionist tools in any given activity, this thesis demonstrated one more reason why C&C prescriptive environmental regulation is limited. As part of the way forward, this research argued for self-regulatory approach for mitigating risks associated with shale gas development as it fosters higher levels of compliance. Self-regulation as an alternative to the prescriptive environmental regulation is unique in the sense that it does not shield the operator from liability even where they have satisfied all set standards as regulated enterprises are seen as the ones taking the shot. Rather, it makes the operator to internalise the cost of his polluting activity that have a high degree of occurrence level. From a legal stand point, where defendants satisfies all safety standards set for the operation of either an aspect of an activity he can be exempted and shielded from liability from an equitable stand point.[738]

However, if policy intervention is implemented to promote a self-regulatory model in setting best practice requirements for enforcing behavioural change, it will definitely impute liability to all defendants in similar industry mix for the consequences of their action. Industry cannot no longer argue that they satisfied all standards they themselves have set to govern their operations. There is the implied assumption that they are expected to review their conducts and standards as they progress in carrying out their activity. By so doing, it is the argument of this thesis that it will definitely spur defendant-operators to always set standards that will definitely forestall the occurrence of harm or preclude the industry from introducing technologies that are not eco-friendly whilst better options exists.

The information asymmetry as popularized by George Akerlof the renowned economist in his paper '*The Market for "Lemons": Quality Uncertainty and the Market Mechanism'*[739] has led to this limited effectiveness the field of environmental regulation has witnessed.

Information asymmetry is otherwise known as imperfect information. It happens when there is a difference in access to relevant knowledge. Therefore, the whole essence of this concept is the key to managing shale gas development because a good understanding of the concept is key to successfully manage and mitigate the relevant risks associated with energy source extraction. As operators of dangerous facilities and the potential victims invariably hold imperfect information about one another, it creates difficulty in understanding the risks involved too.

Linking this issue to shale gas extraction where a lot of information asymmetry that has made regulation quite challenging in that the regulators do not know all that go on underground. This, makes role of risk governance, a difficult objective to achieve when private actors have better access to information than regulators. Thus, liability is more effectual, all else being equal.[740] Hence, allowing wrongdoers to escape liability because of information asymmetry between the operators and victims can create problems whereby victims are neither aware they have been injured, cannot ascertain who is behind their injury, nor cannot acquire sufficient proof to substantiate their claim.

There is also the aspect of cost involved even in situations where such information can be obtained. Obtaining such information is difficult especially for widespread harms, like air and surface water pollution as already discussed in section 1.6. The challenge to locate and obtain

[738]Equity sees that as done which ought to be done (illustrating one of the equitable maxims under common law) This maxim exists to create exception to the norm
[739]See supra Ohio Administrative Code 1501:9-1-02(F) (2014) foot note 618.
[740]See Shavell, S. (1984) supra footnote 288 pp.274–76.

this type of information is also evident where harms are relatively localised, as in some cases of groundwater or soil contamination.

It is upon these costs, information asymmetry, judgement proof defendant and threat to suit problem embedded in regulatory and liability regimes that the work concludes that some of the innovative policy intervention option designs for the effective operations of regulatory and liability approaches to manage problems of information asymmetry associated with energy related development activity and improve the function of liability systems as a complement to traditional regulation. These options include the following: information disclosure, joint and several liability, polluter does not pay model, insurance and financial requirement, shifting the burden of proof rule, appointment of independent well assessor policy intervention options.

It suffice to conclude that the totality of this thesis is to devise a complementary framework to C&C regulation for achieving compliance and policy objectives through the properties of liability and self-regulatory approach to ensure and promote the effective development of shale gas. This is based on the argument that the existing legal regulatory framework governing shale gas fracking is still lacking in addressing some of the legal issues highlighted in this research. Thus, a one size-fit all style of regulation is far from yielding the degree of compliance required from the industry and mitigate the associated risks by transferring the liability to the defendant in shale gas civil claims involving water contamination. Water contamination risks should be treated as a distinct and separate from other shale gas risks because reasonable care cannot easily forestall their frequent level of occurrence considering the present wave of technology in place for extracting these resources. Thus, making shale gas an abnormally dangerous activity that justifies a risk based strict liability regime for water contamination claims.

Evidently, researchers are currently devising a number of policy interventions that would recognize enterprises who developed excellent compliance systems by incentivizing them is the best way possible. One of such incentives for compliance could be a reduced burden of routine inspections, penalty discounts for minor incidents of non-compliance that do happen, simplifying licensing and permits processes, permission to use a label or mark certifying a high level of compliance, and indemnities for voluntary disclosure and correction of non-fraudulent non-compliance. However, one crucial area that will prompt further research is the possibility of researchers to develop regulatory strategies that will offer distinct but standardized regulatory paths to enterprises with different credentials, characteristics and histories of compliance. The combination of instrument mixes that will be offered to compliant enterprises would be more flexible and attractive than that levied on the averagely compliant enetrprises, while another set of regulatory strategies with greater monitoring and reprint requirements might be required for supposed "laggards" or enterprises on "probation" after a serious non-compliance episode.[741] Another likely future area of research outlook will be the role of third parties and civil society in regulation and compliance. Third parties might be either persuaded to join the formal regulatory system via government regulation, or be responsible for regulatory ordering distinct from or subordinate to government regulation.

[741]Gunningham, N. & Grabosky, P. (1998). Smart Regulation: Designing Environmental Policy, Clarendon Press, Oxford.

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